Progress Report

ANALYSIS OF SCANNER DATA FOR CROP INVENTORIES

TM:
I.D. Browne
SF3

16 May 1980 - 15 August 1980

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NASA Contract NAS9-15476

ENVIRONMENTAL
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NOTICES

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16. Abstract

This report summarizes the progress on subject contract during the third quarter of the 1980 contract year. It is comprised of the presentations supporting quarterly project management reviews and a quarterly technical interchange meeting.

17. Key Words	18. Distribution Statement
Crop Inventory, Landsat, Sampling, Temporal Profile Fitting, Machine Labeling, Area Estimation, Software Implementation, Multiyear Estimation	

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PREFACE

The following report serves as the Quarterly Report for Contract NAS9-15476 which is entitled "Analysis of Scanner Data for Crop Inventories". This report describes the work carried out under that contract for the period 16 May 1980 through 15 August 1980.

Work on this contract is performed in the Infrared and Optics Division directed by Mr. Richard R. Legault. Mr. Robert Horvath is the Program Manager for this contract.

This contract, performed by the Environmental Research Institute of Michigan (ERIM) for the Earth Observations Division of the NASA/ Johnson Space Center, is part of the multi-agency AgRISTARS Program and supports both the Supporting Research (SR) and Foreign Commodity Production Forecasting (FCPF) Projects within AgRISTARS. The overall goal of AgRISTARS is to determine the usefulness, cost and extent to which aerospace remote sensing data can be integrated into existing or future U.S. Department of Agriculture (USDA) systems to improve the objectivity, reliability, timeliness and adequacy of information required to carry out USDA missions.

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CORN AND SOYBEAN CLASSIFICATION TECHNOLOGY DEVELOPMENT FOR AREA ESTIMATION

QUARTERLY TECHNICAL REVIEW

AUGUST 20, 1980

ENVIRONMENTAL RESEARCH INSTITUTE OF MICHIGAN
UNIVERSITY OF CALIFORNIA AT BERKELEY
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CORN AND SOYBEAN CLASSIFICATION TECHNOLOGY DEVELOPMENT FOR AREA ESTIMATION

OBJECTIVES

- CONDUCT END-TO-END EXPLORATORY EXPERIMENTS IN CLASSIFICATION TECHNOLOGY FOR CORN AND SOYBEANS IN SUPPORTS OF PILOT EXPERIMENTS
- DELIVER PILOT-COMPATIBLE C/S AREA ESTIMATION PROCEDURES
- SUPPORT PILOT EXPERIMENT

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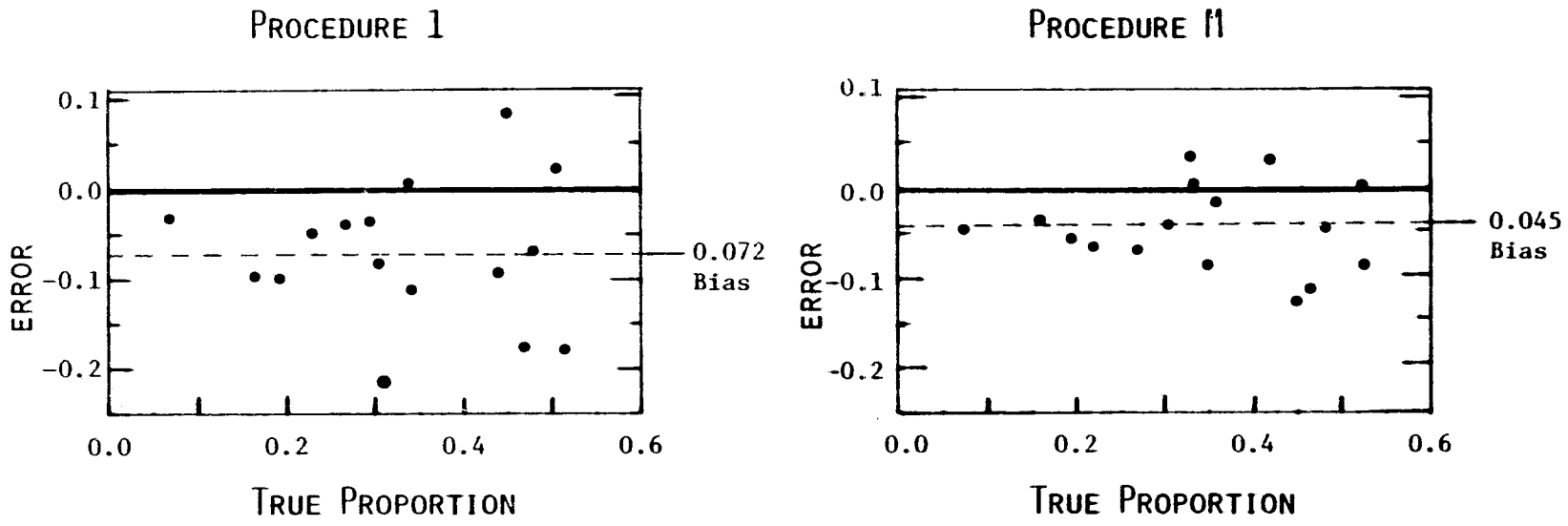
PROCEDURE M EVALUATION

17 TY 1978 SMALL GRAINS SEGMENTS



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ANALYST LABELING WITH DFS

(11 BLIND SITES)

- DELTA FUNCTION STRATIFICATION R-VALUE .713 (.296 TO .963)
- ANALYST LABELING ACCURACY (209 DOTS)

SUMMER CROP		95.95%
	CORN	90.64%
	SOYBEANS	85.68%
OTHER		96.31%
	SMALL GRAINS	80.22%

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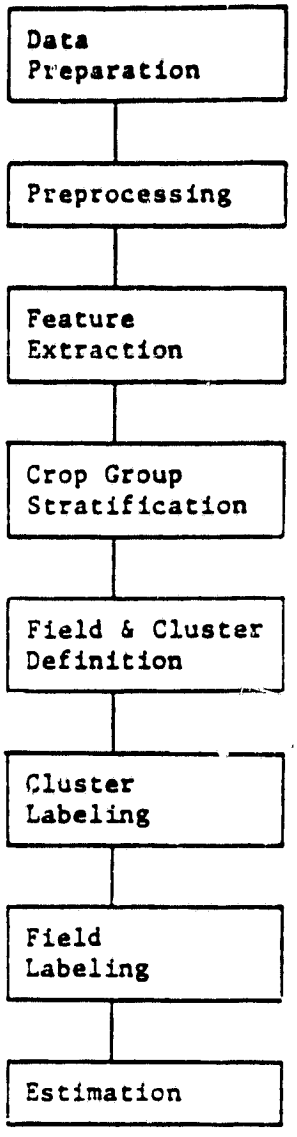
BASELINE CORN/SOYBEAN

PROCEDURE FLOW



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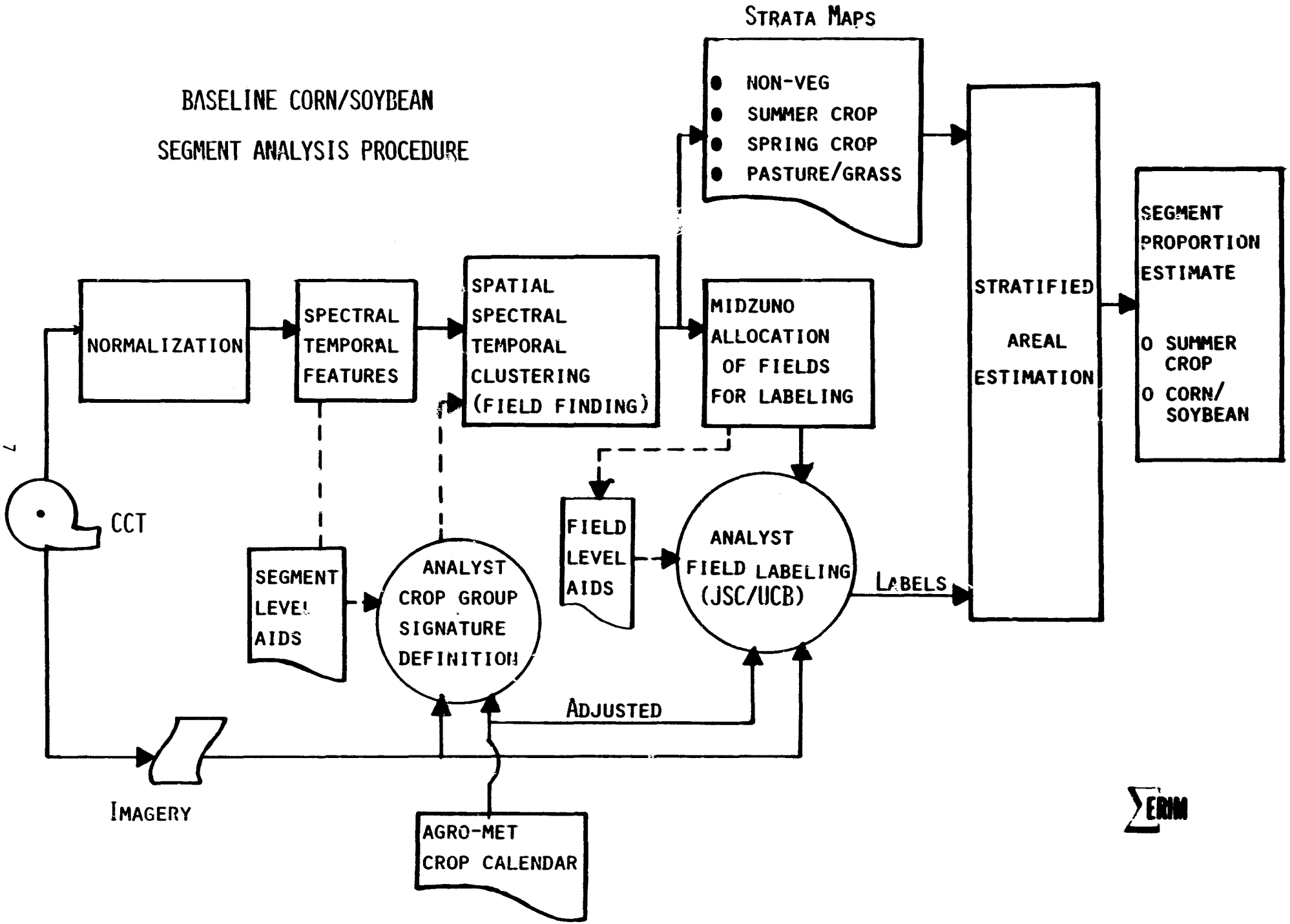
SALIENT CHARACTERISTICS OF BASELINE

- STRATIFIED AREA ESTIMATES ARE PRODUCED BY DIRECTING THE SAMPLE TO CLUSTERS THAT ARE FORMED IN AN UNSUPERVISED MANNER
- LABELING DECISIONS FLOW FROM THE GENERAL TO THE SPECIFIC, E.G., SUMMER CROPS ARE IDENTIFIED USING TEMPORAL INFORMATION BEFORE SOYBEANS ARE IDENTIFIED USING SPECTRAL INFORMATION
- LABELING IS CONDUCTED ONLY TO THE LEVEL WARRANTED BY THE ACQUISITION HISTORY OF THE SEGMENT

BASELINE CORN/SOYBEAN

SEGMENT ANALYSIS PROCEDURE



MAJOR TASKS

SUPPORTING RESEARCH

- Current Classification for Area Estimation Technology Development
- Advanced (P2) Classification for Area Estimation Technology Development
- Classification for Area Estimation Technology Development with Thematic Mapper

FOREIGN COMMODITY PRODUCTION FORECASTING

- Classification Procedure Design
- Labeling Logic and Analyst Procedures Development
- Procedure Implementation
- Exploratory Test and Evaluation
- Classification in Support of Pilot Experiment

ED SCHEFNER
LYNN EUDEY

JULIE ODENWELLER
CLAIRE HAY

OREST MYKOLENKO
MIKE METZLER

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CORN/SOYBEAN PROCEDURE IMPLEMENTATION FOR FY81 U.S. C/S PILOT EXPERIMENT

PROJECT: FOREIGN COMMODITY PRODUCTION FORECASTING

PROJECT ELEMENT: CLASSIFICATION

TASK: U.S. CORN/SOYBEAN PROCEDURE IMPLEMENTATION

PERFORMING ORGANIZATION: ERIM/UCB

PRESENTORS: M. METZLER
O. MYKOLENKO

AUGUST 20, 1980

OBJECTIVE

IMPLEMENT THE C/S SEGMENT AREA ESTIMATION PROCEDURE

FOR THE FY81 U.S. PILOT EXPERIMENT

KEY ISSUE ADDRESSED

THERE DOES NOT CURRENTLY EXIST AN IMPLEMENTED CAPABILITY FOR PERFORMING SEGMENT PROPORTION ESTIMATION FOR THE FY81 U.S. C/S PILOT

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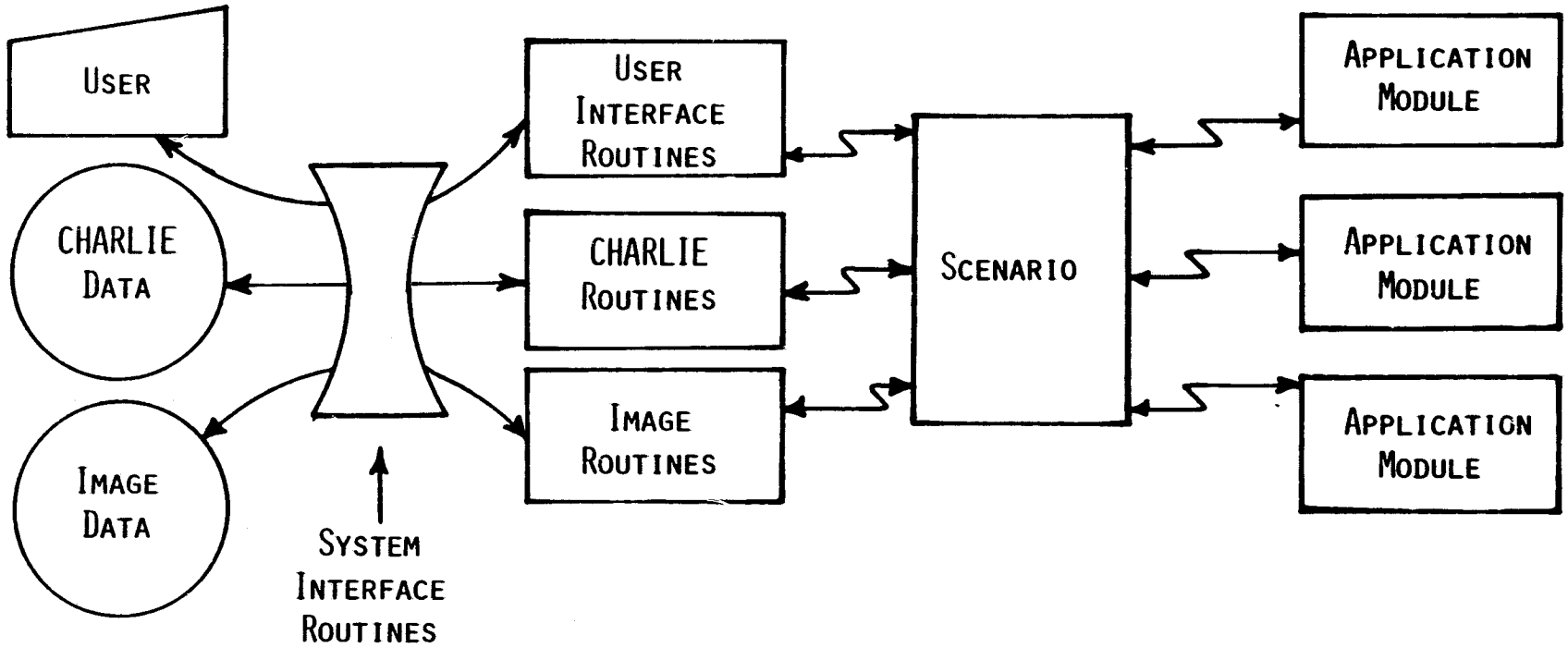
PURPOSE OF PRESENTATION

THIS PRESENTATION IS AN OVERVIEW OF SOFTWARE DESIGN CONCEPTS UTILIZED IN THE IMPLEMENTATION OF THE BASELINE C/S AREA ESTIMATION PROCEDURE

SYSTEM ORGANIZATION



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KEY DESIGN ELEMENTS

- Simple High Level User Interface
- Status and Tracking
- Efficient Single Function Application Modules
- Data Management Services
- Operating System Independence

PILOT USER

- Is Not Required to be Computer Sophisticated
- Uses a Simple Command Language
- Is Guided Through the Procedure by the Software
- Can Operate in BATCH or INTERACTIVE MODE
- Is Isolated from Data Management

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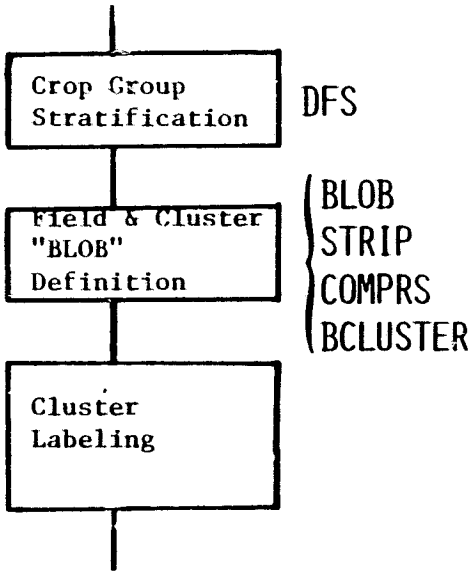

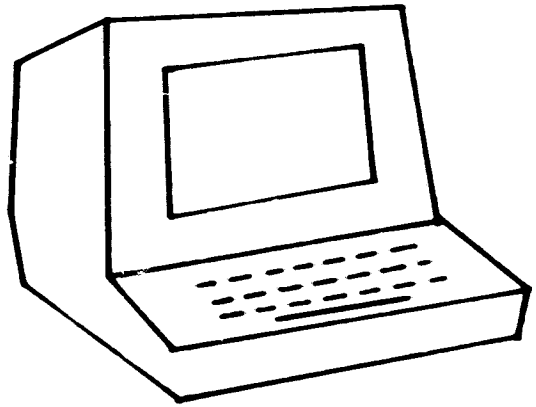

BLOB SEG1863

ENTER NUMBER OF ACQUISITIONS AND DATES

4, 210, 235, 245, 261

END OF BLOB SCENARIO

STATUS AND TRACKING

- PROVIDES STATUS REPORT TO PILOT MANAGER
- ERROR LOGGING
- PROCEDURE FLOW VERIFICATION
- PROVIDES A BACKUP CAPABILITY

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******** Audit Trail for Segment 1864 ********

Name of caller	Type of call	Date	Time
FIELD_CLUSTER_DEFINITION	Scenario	08/20/80	08:55:00
[... CCREATE(Blob image)	Charlie	08/20/80	08:55:30
.... IIMAGE(reading Tascap)	Data service	08/20/80	08:57:04
.... IIMAGE(image Screen)	Data service	08/20/80	08:59:46
[...[... BLOB (entered)	Application	08/20/80	09:20:47

######## ERROR ENCOUNTERED IN ROUTINE BLOB ######## 08/20/80 09:25:31 ########
######## Spatial threshold parameter = 0, ########
######## illegal parameter setting, Severity Level 16 ########

********** Error Summary **********

Severity Level	Number of Occurrence
16	1

SCENARIO

- Is Written in PREFOR (FORTRAN)
- Provides an Environment for the Application Modules
- Supplies Application Modules with Data
- Calls Status and Tracking Routines

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APPLICATION MODULE

- HAS ONLY ONE FUNCTION
- WRITTEN IN PREFOR (FORTRAN)
- MAY NOT PERFORM ANY I/O
- RECEIVES/TRANSMITS ALL DATA VIA THE PARAMETER LIST
- CALLS STATUS AND TRACKING ROUTINES
- PROCESSES DATA SCAN LINE BY SCAN LINE OR IN MULTIPLE LINE REGIONS
- MAY PROCESS MULTIPLE IMAGES CONCURRENTLY
- PERFORMS EXTENSIVE ERROR CHECKING

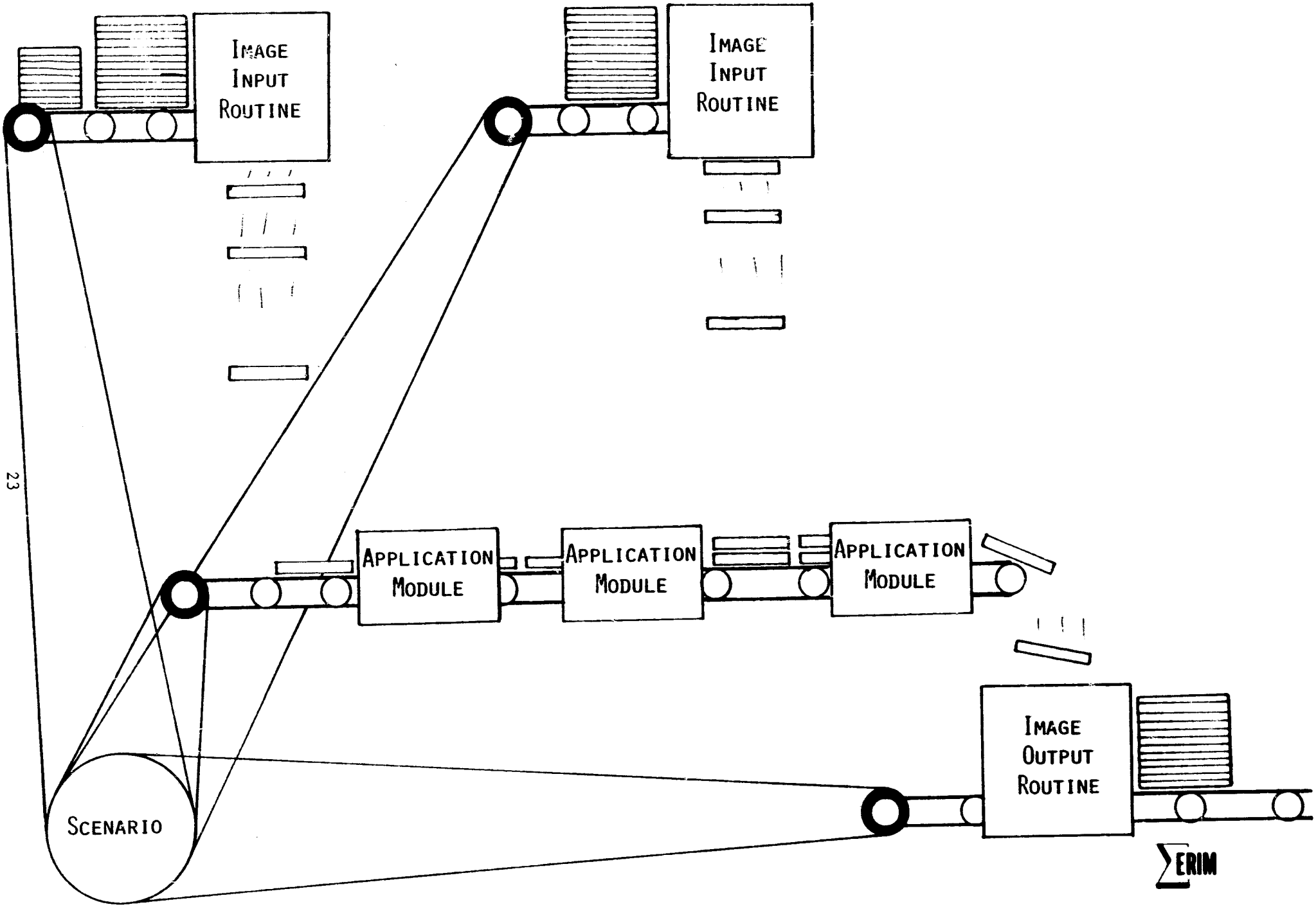


IMAGE
INPUT
ROUTINE
IMAGE
INPUT
ROUTINE
APPLICATION
MODULE
APPLICATION
MODULE
APPLICATION
MODULE
IMAGE
OUTPUT
ROUTINE
SCENARIO
ERIM

DATA/DATA SERVICES

IMAGES

- Exist in Internal and External Formats
- May be of Arbitrary Size
- Data are Never Added to an Image, But Become a New Image

IMAGE FORMAT ROUTINE

- Reads/Writes an Image One Scan Line at a Time
- Converts Between Internal and External Image Formats
- Follows Other Application Module Rules

INTERNAL IMAGE FORMAT

- Number of Pixels - NPIX
- Number of Channels - NCHAN
- Data Array for One Scan Line (Dimension NCHAN*NPIX)
- Mask for One Scan Line (Dimension NPIX)
- Line Number of Current Scan Line
- Data Array Mode (Real vs Integer) Vector (Dimension NCHAN)
- Channel Label Vector (16 characters per channel)
- Acquisition Date Vector (Dimension NCHAN)
- Window (first/last scan line/pixel, scan line/pixel skip factor)
- Image Key (Unigue 48 character image identifier)

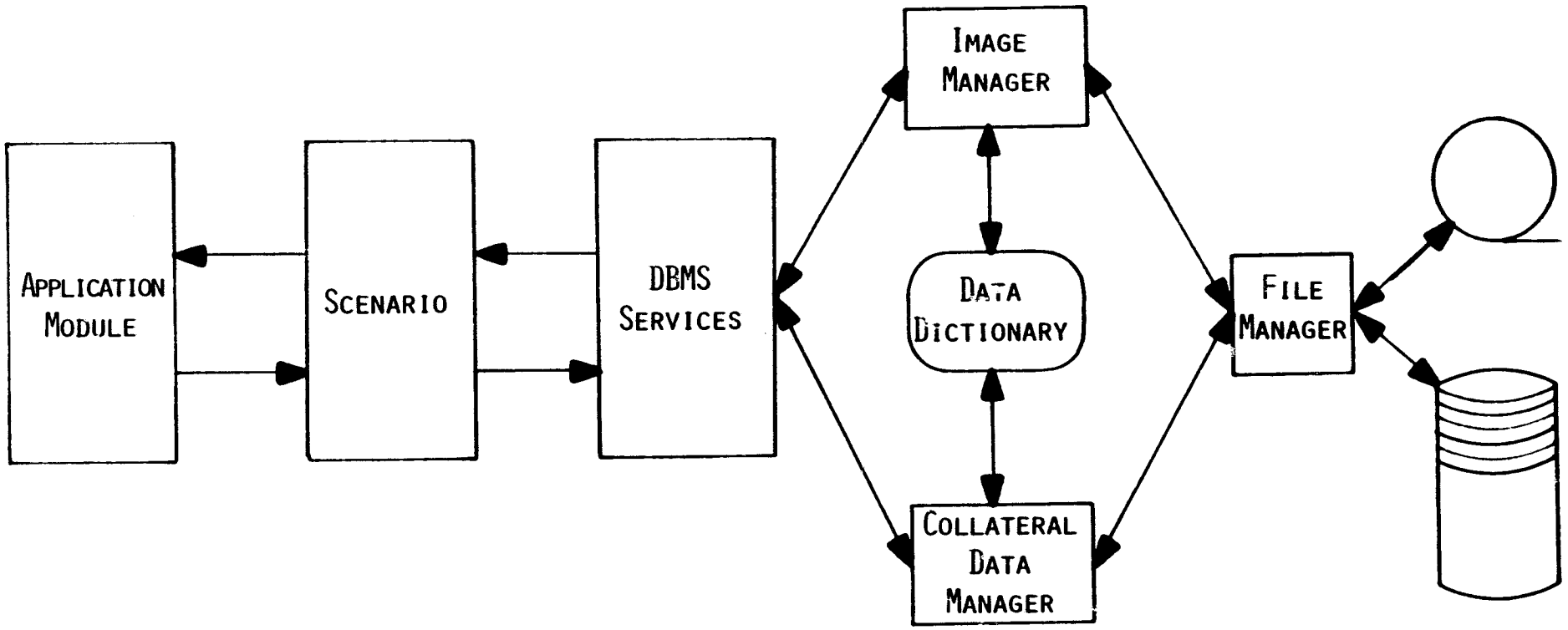
DATA/DATA SERVICES

CHARLIE Provides DBMS Functions Needed by the Pilot Software

- Stash for Intermediate Results
- Separate CHARLIE for Each Segment Processed
- Scenarios May Manipulate Entities in CHARLIE with Operators:

  CREATE
  SET
  PUT
  GET
  DESTROY

- Application Modules See CHARLIE Entities as FORTRAN-Declarable Items Which May be RESHAPEd to Desired Size


APPLICATION MODULE
SCENARIO
DBMS SERVICES
IMAGE MANAGER
DATA DICTIONARY
COLLATERAL DATA MANAGER
FILE MANAGER

ERIM

SYSTEM INTERFACE ROUTINES

PROVIDE ACCESS TO OPERATING SYSTEM SERVICES

- ALL INPUT/OUTPUT
- VIRTUAL MEMORY ALLOCATION/DEALLOCATION
- CURRENT TIME AND DATE
- FILE MANAGEMENT

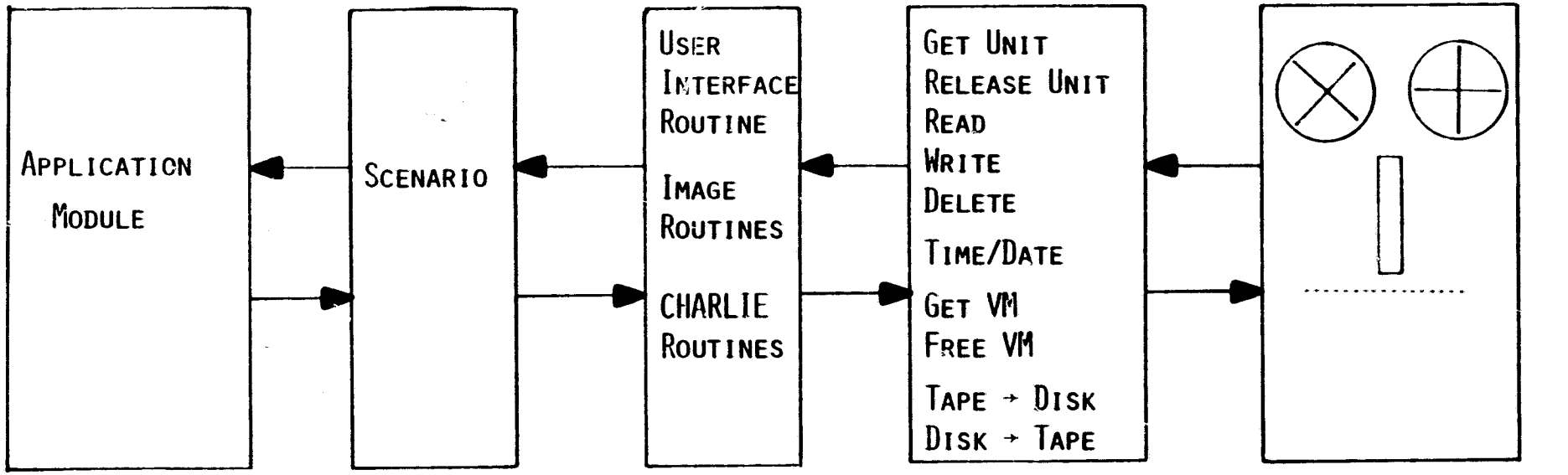
ISOLATE SYSTEM DEPENDENT SERVICES

MINIMIZE EFFORT NEEDED TO TRANSPORT PROCEDURE

SYSTEM INTERFACE ROUTINES

FEATURES OF I/O PORTION OF SYSTEM INTERFACE ROUTINES

- Devices and Files Referenced by 48 Character Key
- Calling Module Need Not Know Data Source/Destination
- Catalog of all Disk and Tape Files is Monitored
- Limited Protection of Files is Provided
- Movement Between Disk and Tape is Simple
- Tape and Disk Resources are Efficiently Managed


APPLICATION MODULE
SCENARIO
USER INTERFACE ROUTINE
IMAGE ROUTINES
CHARLIE ROUTINES
GET UNIT
RELEASE UNIT
READ
WRITE
DELETE
TIME/DATE
GET VM
FREE VM
TAPE → DISK
DISK → TAPE
VM/CMS ON 3031/4341
MTS ON 470V/7

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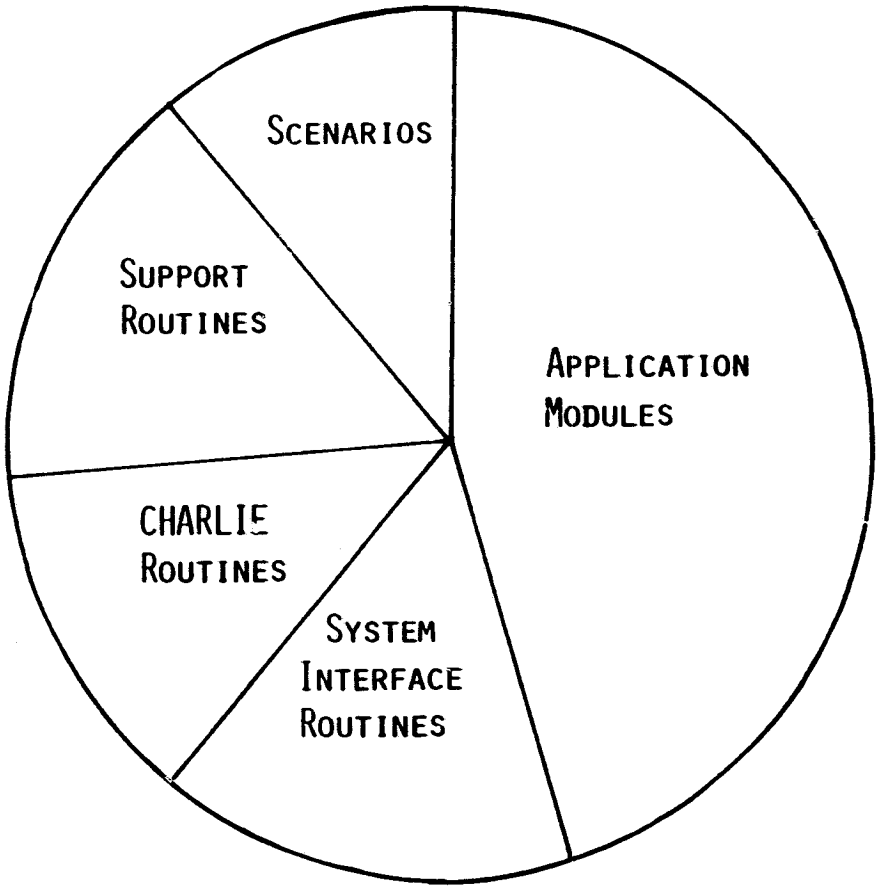
IMPLEMENTATION STATUS



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MILESTONES

• Delivery to Existing CMS Facility (LARS)	1 Oct 80
• Initial User Documentation	1 Oct 80
• JSC Shakedown Begins	1 Oct 80
• Arrival of ERSYS Computer	1 Dec 80
• Redelivery onto ERSYS Computer	6 Dec - 15 Jan 81
• C/S Pilot Begins	15 Jan 81

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SUMMARY

- User is Isolated from the Detailed Workings of the Software
- Application Modules Isolated from the Operating System and Data Services
- Only the System Interface Routines are Dependent on the Operating System
- Application Modules Process Arbitrary Size Images in Efficient Assembly Line Fashion

PROGRESS ON MACHINE-ORIENTED LABELING PROCEDURE FOR WHEAT

PROJECT: SUPPORTING RESEARCH

PROJECT ELEMENT: AREA ESTIMATION DESIGN

TASK: LABELING PROCEDURES DEVELOPMENT

PERFORMING ORGANIZATION: ERIM

PRESENTORS: W. MALILA AND E. CRIST

AUGUST 20, 1980

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OUTLINE

- Overview
- Technical Discussion
- Plans

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KEY ISSUE ADDRESSED

THE LABEL ASSIGNMENT STEP HAS BEEN THE GREATEST SOURCE OF ERROR IN PROPORTION ESTIMATION PROCEDURES. THERE IS A NEED FOR MORE ACCURATE AND CONSISTENT LABELING TO SUPPORT AREA ESTIMATION.

OBJECTIVES

- OVERALL:
  - To Develop a Series of Candidate Labeling Procedures for Test and Evaluation in Exploratory and Pilot Experiments Within SR and FCPF. These procedures Should Be:
    - OBJECTIVE
    - ACCURATE
    - ADAPTABLE
- SPECIFIC:
  - To Develop an End-of-Season Labeling Procedure for Spring Wheat Which is Machine-Oriented and Utilizes Temporal-Spectral Profile Analysis Technology.
  - To Develop Tools for Continued Research and Development of Labeling Procedures.

GENERAL APPROACH FOR MACHINE-ORIENTED LABELING PROCEDURE FOR SPRING WHEAT

- Examined Existing Technology and Information
  - Labeling and classification procedures and results
  - Landsat data and agronomic information
- Formulated Preliminary Design
  - Reported last quarter
  - Emphasizes temporal-spectral profile technology
- Conduct Research and Development of Procedural Elements Using:
  - Agronomic information
  - Landsat data sets for a variety of sites and conditions

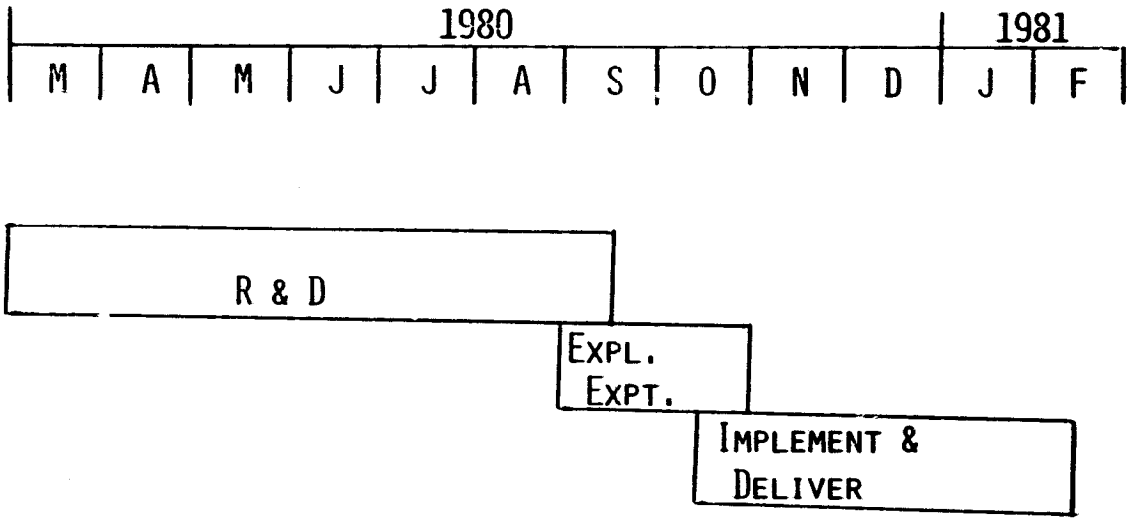
GENERAL APPROACH (CONT.)

- DEFINE A LABELING PROCEDURE FOR FEASIBILITY TESTING
  - INCLUDE A LIMITED NUMBER OF ALTERNATIVE COMPONENTS
  - CODE ON ERIM COMPUTATIONAL FACILITY
- CONDUCT AN EXPLORATORY EXPERIMENT
  - USE INDEPENDENT MULTIYEAR LANDSAT DATA
  - EVALUATE PARAMETERS AND ALTERNATIVES
- FINALIZE PROCEDURE, IMPLEMENT, AND DELIVER TO SF3
  - DETAILS OF DELIVERY TBD
    (DELIVERY TO LARS COMPUTER ASSUMED)

SCHEDULE FOR

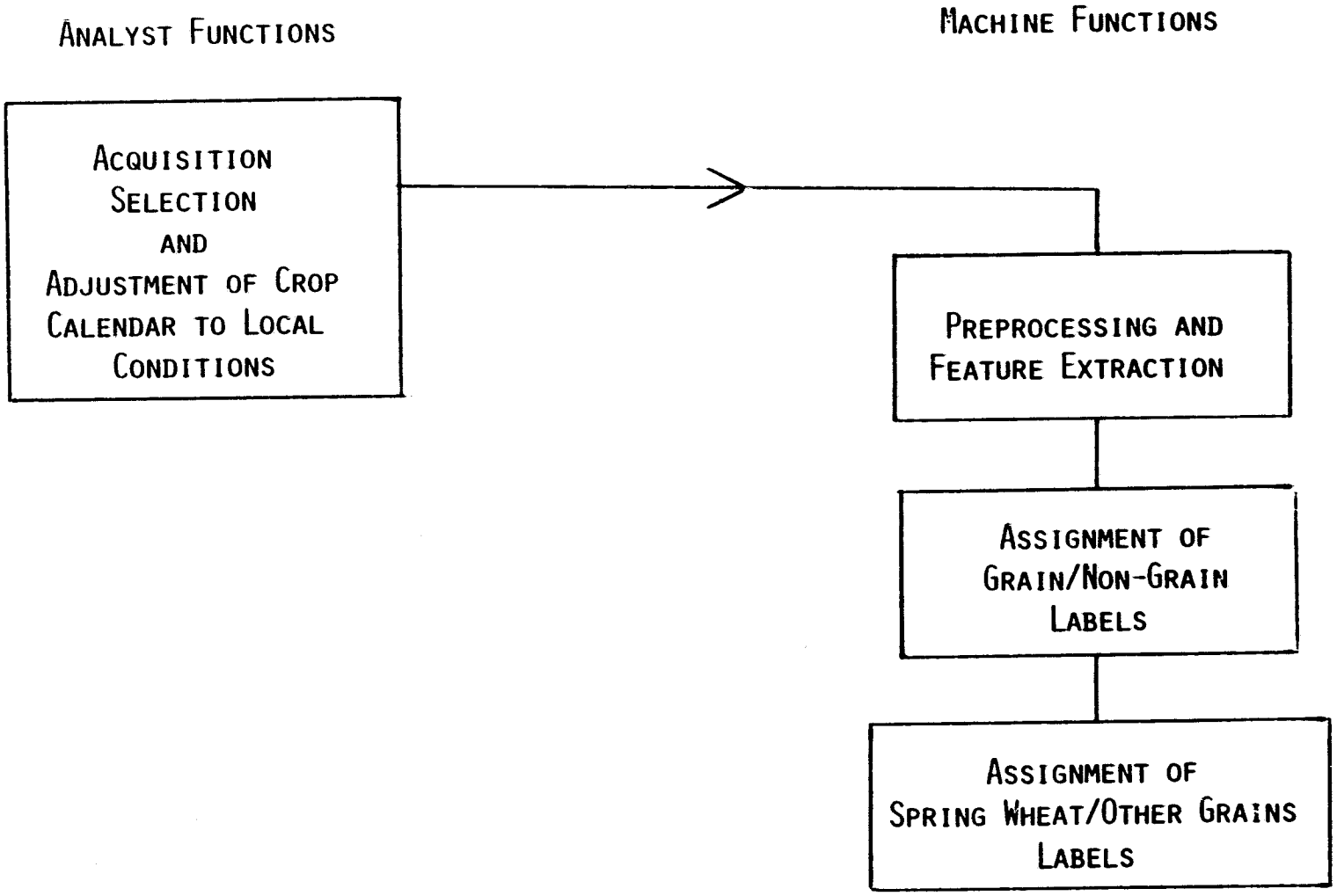
MACHINE-ORIENTED LABELING PROCEDURE

FOR SPRING WHEAT



BLOCK DIAGRAM

MACHINE-ORIENTED LABELING PROCEDURE FOR SPRING WHEAT



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MAJOR FEATURES

- Analyst Functions Do Not Include Label Decisions
- Preprocessing Used to Normalize Data
  (satellite calibration, sun angle, haze correction)
- Tasseled-Cap Transformation Applied
- Quasi-Fields (e.g., blobs) are Recommended Labeling Targets
- Grain/Non-Grain Decisions are Based on Temporal-Spectral Profile Features and Comparisons
- Existing ERIM Labeling Technique Used to Partition Spring Small Grains into Wheat/Non-Wheat

SUMMARY OF STATUS

- RESEARCH AND DEVELOPMENT NEARLY COMPLETE
  - CROP TEMPORAL-SPECTRAL PROFILE CHARACTERIZATION
  - FEATURES AND GOODNESS-OF-FIT CRITERIA
  - ANALYST FUNCTIONS TO BE ADAPTED FROM ERIM/JCB CORN/SOYBEANS BASELINE PROCEDURE
- PREPARATIONS FOR EXPLORATORY EXPERIMENT UNDERWAY
  - MAJOR FACTORS FOR TESTING IDENTIFIED
  - DATA SET PREPARATION IN PROGRESS, BUT NOT ALL DESIRED DATA HAVE BEEN RECEIVED

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ANALYST FUNCTIONS

- ACQUISITION SELECTION
  - Consider Clouds/Haze, Consecutive Days, etc.
  - Where System Limitations Restrict Total Number of Acquisitions Allowable, Also Consider Time of Season, Relative Spacing
- CROP CALENDAR ADJUSTMENT
  - Employ UCB Method, as Contained in DFS Procedure, to Adjust Spring and Summer Crop Groups
  - Adjust Crop Types Within Groups Using Historical Relationships

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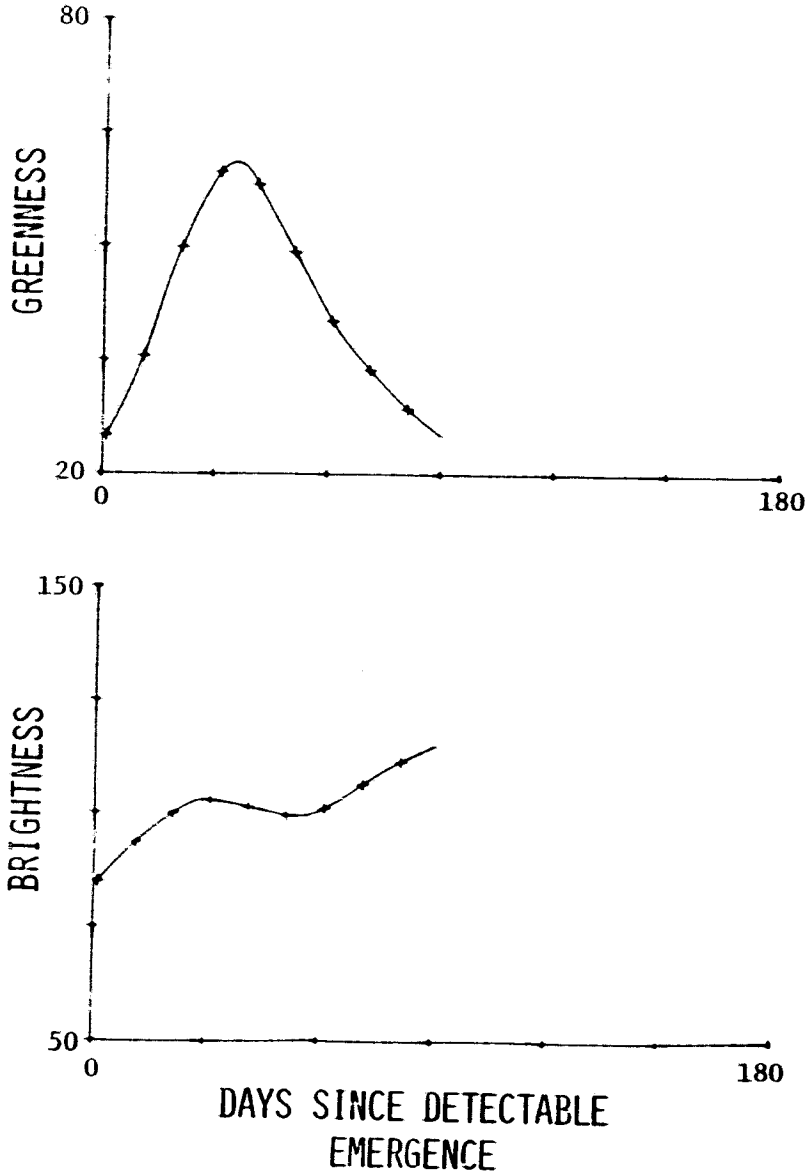
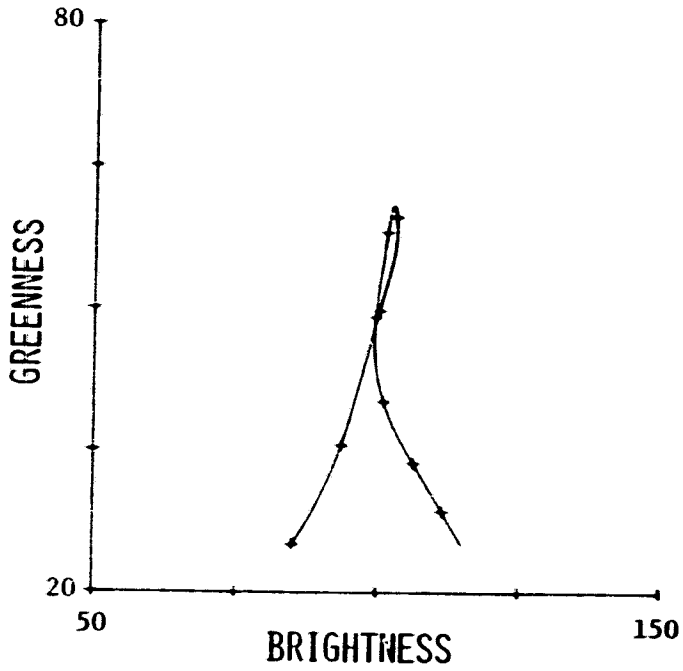
DERIVATION OF PROFILES - METHOD EMPLOYED

- Estimate Profile Shapes for Each Crop or Crop Group by Analysis of Multi-Temporal Clusters, Agronomic Information
- Shift All Data for Given Crop to its Greenness Profile
- Compute Mean Values, Polynomial Fits to Means of Shifted Data (Greenness and Brightness) or Fit Model Form to Greenness
- Adjust Profiles Based on New Fits
- Recompute Shifts
- Iterate if Necessary
- Compute Variances About Profile Using Shifted and Scaled Data

PROFILE FEATURES (CONT'D)

SPRING SMALL GRAINS





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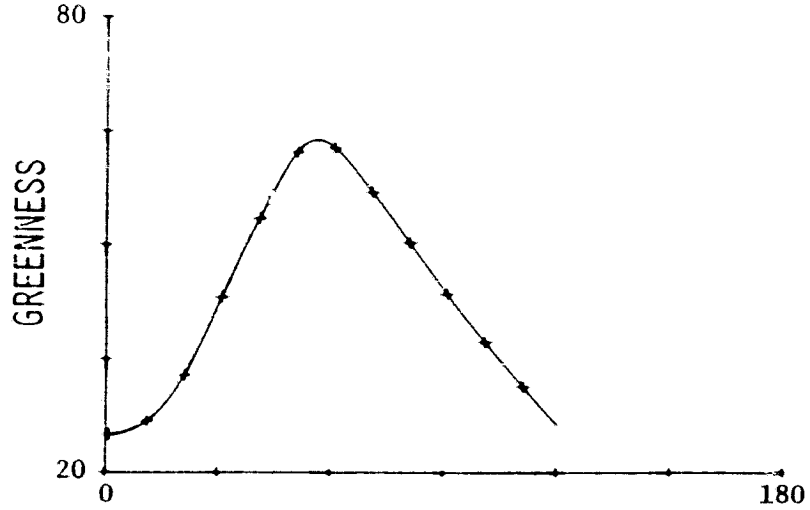
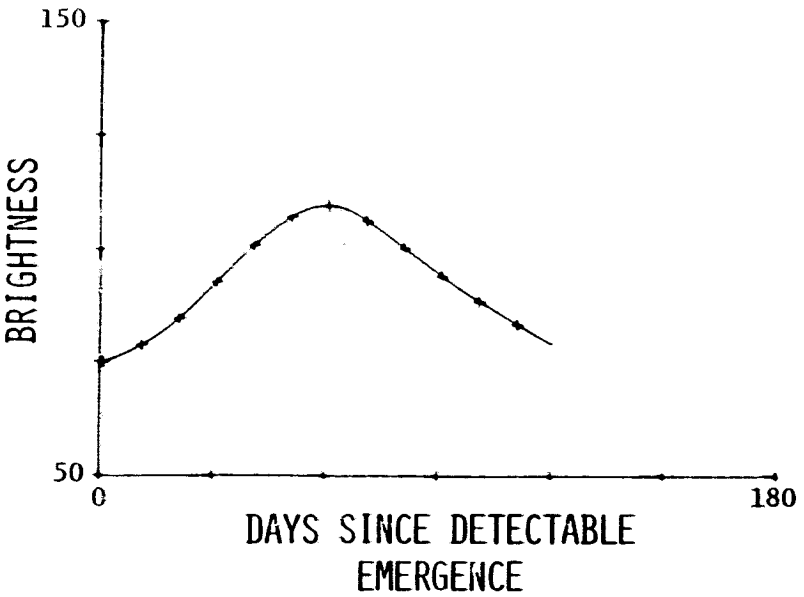
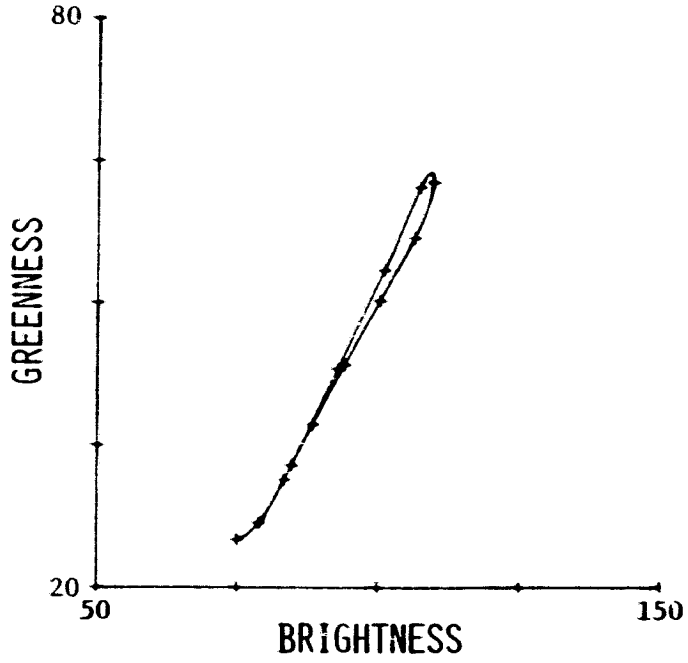
PROFILE FEATURES (CONT'D)

SUNFLOWERS

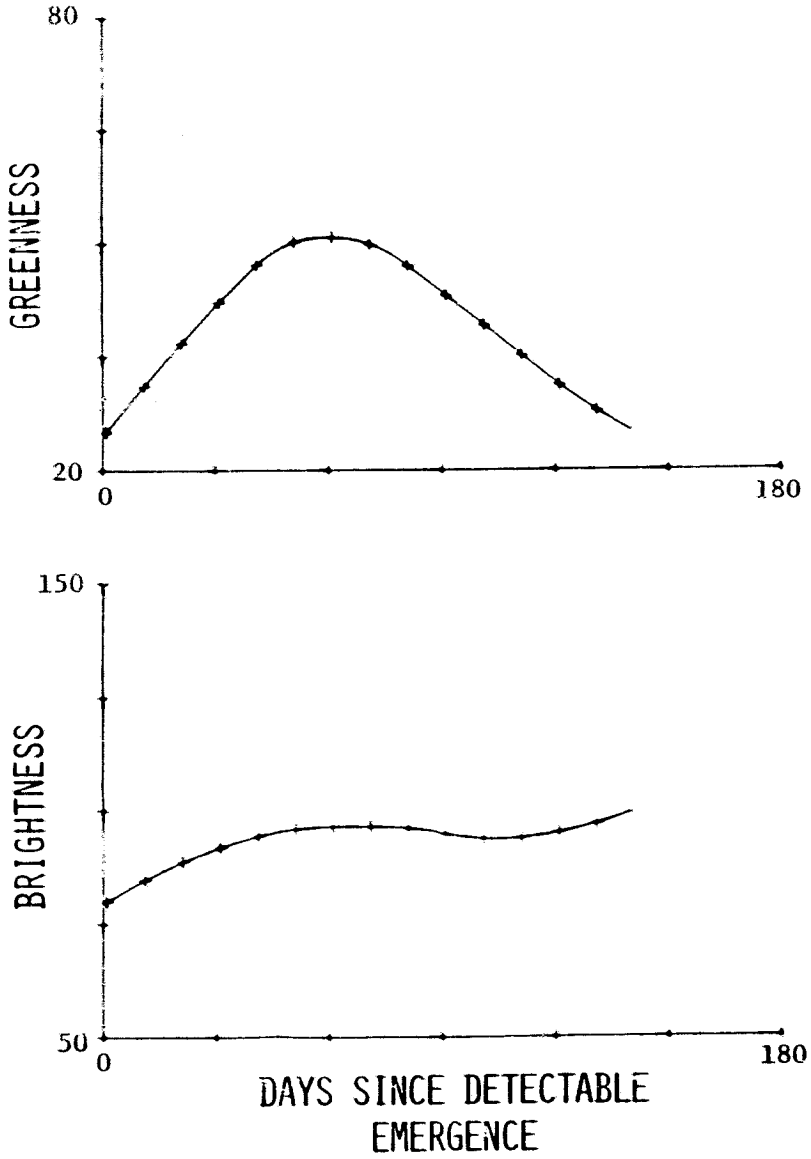


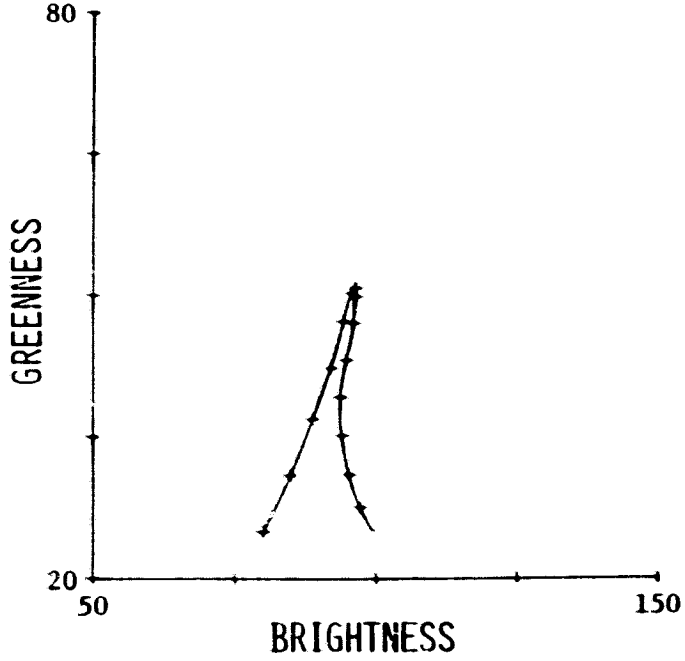




PROFILE FEATURES (CONT'D)

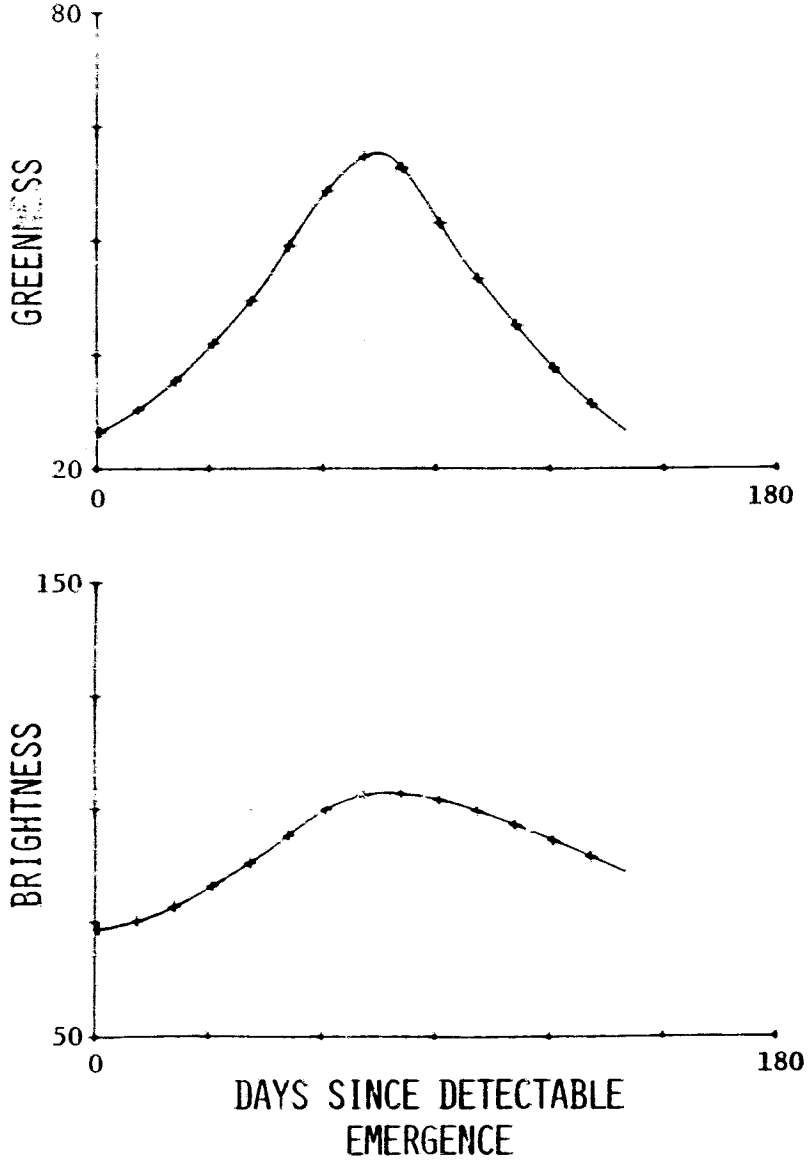
CORN

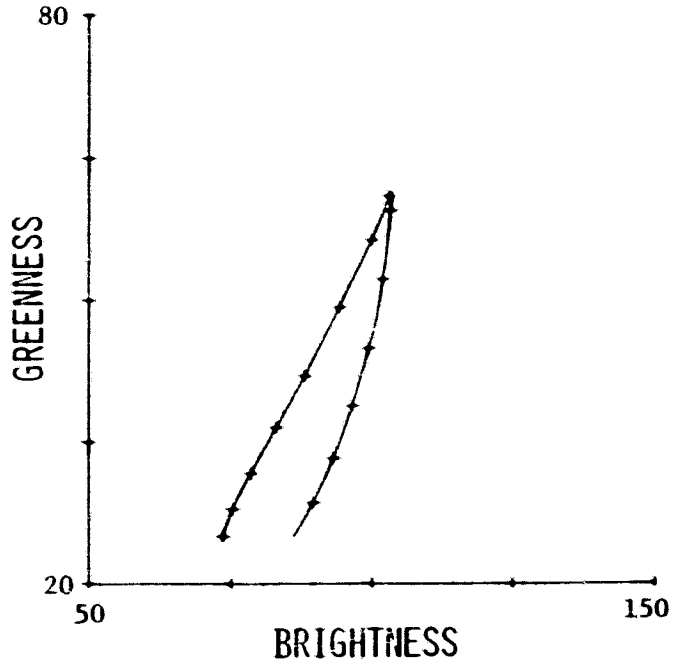




PROFILE FEATURES (CONT'D)

SOY BEANS





GRAIN/NON-GRAIN LABELING TECHNIQUE

APPROACH

- Determine Temporal Adjustment and Scaling Required to Maximize Fit of Data to a Series of Greenness Profiles
- Compute a Measure of Goodness-of-Fit of Shifted and Scaled Data to Each Greenness Profile and Its Accompanying Brightness Profile, and a Probability Related to the Temporal Shift Required
- Identify the M Profile Sets Which Pass a Combined Probability Test Using All Three Factors
- Label the Data Point as Follows
  - $M = 0$ unlabelable
  - $M = 1$ assign data to the associated class
  - $M > 1$ select the label from among the M classes, using another measure of closeness

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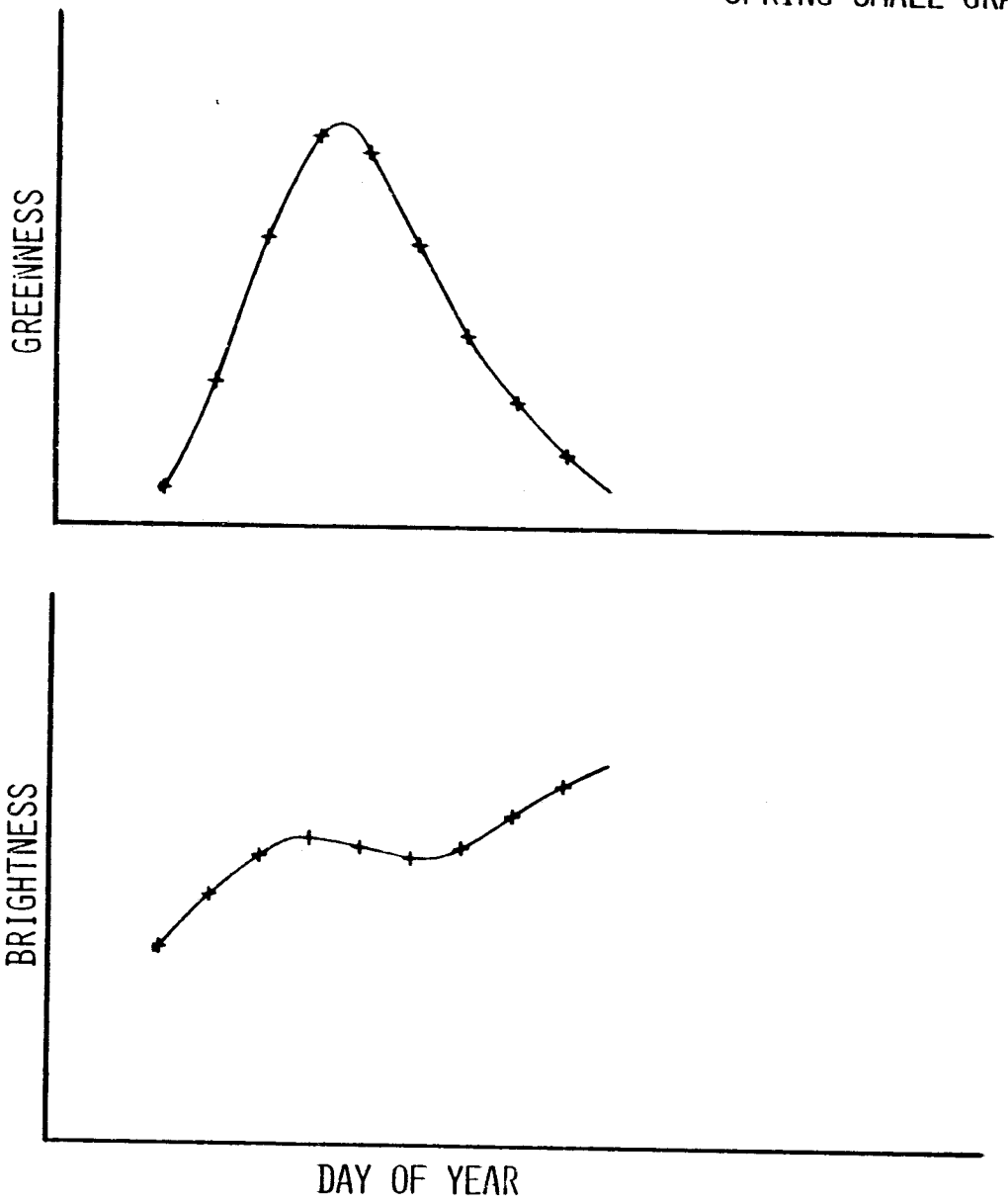
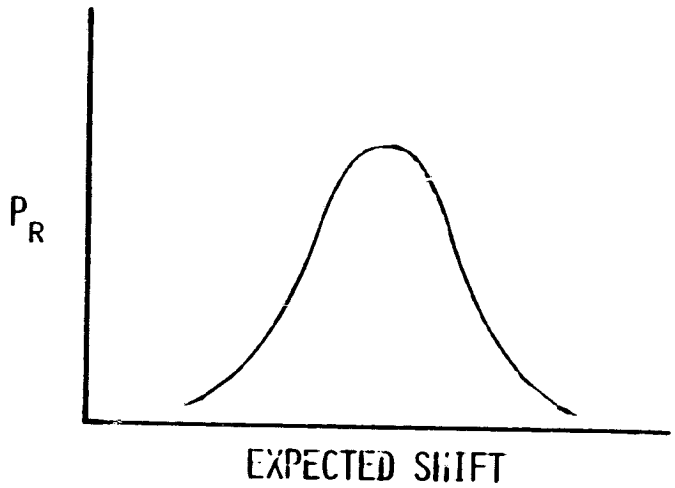
DECISION LOGIC

SELECTION OF CANDIDATE PROFILES

- Three Tests of Hypotheses Related to
  - Goodness-of-fit to Greenness profile
  - Goodness-of-fit to Brightness profile
  - Temporal shift required to maximize Greenness fit
- Utilize Weights to Reflect Relate Importance/Sensitivity of the Three Tests
- Choose Those Profiles Which Cannot be Rejected at a $1-\alpha$ Level of Significance, Using a Combined Test Statistic

SPRING SMALL GRAINS





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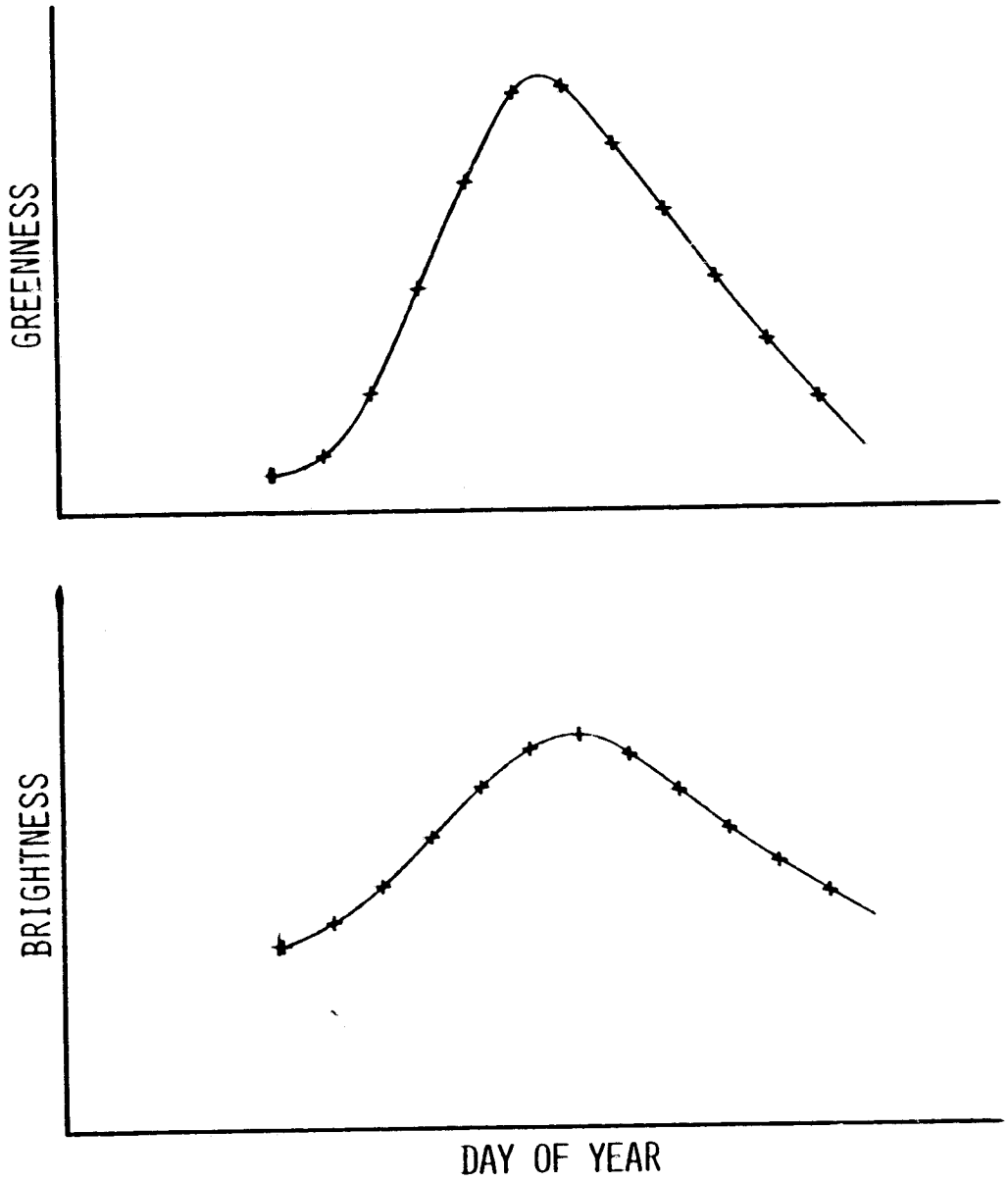
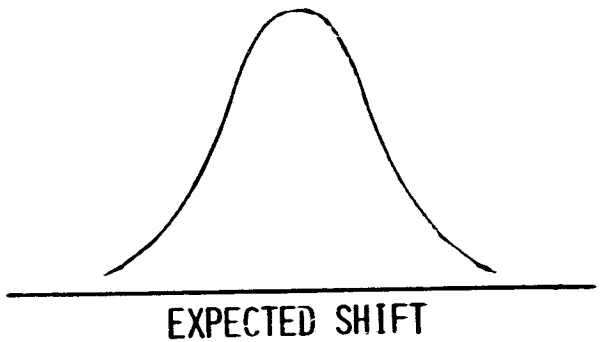
SUNFLOWERS



P_R



ERIM

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DECISION LOGIC (CONT'D)

POSSIBLE METHOD FOR CANDIDATE SELECTION [FISHER'S OMNIBUS PROCEDURE]*

- FOR EACH OF S TESTS, GENERATE TEST STATISTICS $t_1,\ldots,t_S$ WITH PROBABILITIES $P_1,\ldots,P_S$ WHERE $P_I = P_R\left[T_I \geq t_I\right]$, BASED ON

  H_0: SAMPLE $x(t)$ IS AN ELEMENT CLASS I

  WITH ASSUMED INDEPENDENCE OF THE TEST STATISTICS

- ASSIGN POSITIVE WEIGHTS $\delta_1,\ldots,\delta_S$ TO THE TESTS, AND COMPUTE AN OVERALL STATISTIC T WHERE

$$T = -2\sum_{I=1}^{S} \delta_I \mathrm{LN} P_I$$

*SUGGESTED BY DR. JACK TUBBS, UNIVERSITY OF ARKANSAS

DECISION LOGIC (CONT'D)

- H_0 IS REJECTED WHEN $\hat{\alpha} < \alpha$, WHERE

$$\hat{\alpha} = P_R \left[X^2(v) \geq T \right]$$

$X^2(v)$ DENOTES A CHI-SQUARE VARIABLE WITH $v = 2\sum_{I=1}^{S} \delta_I$ DEGREES OF FREEDOM

- SIGNIFICANCE OF THE RESULT OF THE COMBINED TEST IS THE SAME AS THAT OF THE INDIVIDUAL TESTS

DECISION LOGIC (CONT'D)

SELECTION OF LABEL

OPTIONS:

- CHOOSE CLASS WITH THE LARGEST $\hat{\alpha}$ IN THE CANDIDATE TEST
- CHOOSE CLASS WITH MAXIMUM LIKELIHOOD
- ASSIGN PROBABILITY LABELS (FUTURE)

SPRING WHEAT LABELING TECHNIQUE

REVIEW

- Operates on Samples Labeled 'Grain' by Previous Step
- Adjusts for Field-to-Field Differences in Stage of Development
- Adjusts for Segment-Level Conditions
  - Moisture status
  - Soil brightness
- Utilizes Spectral Differences Between Wheat and Barley at the Time of Turning (Soft Dough Stage)

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EXPLORATORY EXPERIMENT

- DATA SET CONSISTS OF ≤35 SEGMENTS FROM 3 YEARS, 4 STATES

  3 FROM 1976

  10 FROM 1977

  ≤22 FROM 1978 (DEPENDING ON AVAILABILITY)

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EXPLORATORY EXPERIMENT (CONT'D)

EVALUATIONS TO BE MADE

- LABELING ACCURACY, VARIABILITY
  - OVERALL
  - BY CROP
  - BY YEAR
  - BY APU
- COMPARISON OF MACHINE RESULTS TO PHASE 3 AI DOT LABELS
- INTERACTIONS OF LABELING ACCURACY WITH
  - CROP CALENDAR ADJUSTMENT
  - BLOB PURITY
  - ACQUISITION SELECTION

ERIM

EXPLORATORY EXPERIMENT (CONT'D)

CONFIGURATION

- SIMULATE ANALYST CROP CALENDAR ADJUSTMENT
  - USE ACTUAL START DATES, BASED ON GROUND TRUTH AND COMPUTED SHIFTS
  - INTRODUCE ERRORS FOR EVALUATION PURPOSES
- OPERATE ON SUPERVISED BLOBS (GROUND TRUTH USED AS CONTROL)
  - ALSO USE UNSUPERVISED BLOBS IN A SUBSET OF DATA FOR PURITY EVALUATION
- POTENTIAL FOR USING SEVERAL DIFFERENT THRESHOLD VALUES, PARAMETER SETTINGS

PLANS FOR NEXT QUARTER

- COMPLETE DESIGN ANALYSIS
  - FINAL DEFINITION OF PROFILES
  - DETERMINATION OF GOODNESS-OF-FIT MEASURES, ATTAINABLE SIGNIFICANCE, ETC.
  - EVALUATION OF PROCEDURE ON TRAINING DATA
- CONDUCT EXPLORATORY EXPERIMENT
  - INDEPENDENT DATA SET
- BEGIN IMPLEMENTATION FOR DELIVERY

ERIM

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EVALUATION OF MULTIYEAR SAMPLING ESTIMATION AND CHANGE

Project: FCPF

Project Element: Sampling & Aggregation

Task: Multiyear Evaluation & Change Analysis

Performing Organization: ERIM

Presentors: W. F. Pont and R. Kauth

August 20, 1980

ERIM

MULTIYEAR SAMPLING/ESTIMATION

- OBJECTIVES
  - Transfer TAMU's Multiyear Sampling/Estimation Technology to JSC Via LARS
  - Evaluation of TAMU's Multiyear Sampling/Estimation Procedures
- APPROACH
  - Research and Development of Multiyear Sampling/Estimation Procedures (TAMU)
  - Implement Procedures on LARS Computer (ERIM)
  - Develop Experiment Design (ERIM, JSC, TAMU)
  - Evaluation of Procedures (ERIM)

EVALUATION OF MULTIYEAR SAMPLING/ESTIMATION

CURRENT PROGRESS

- IMPLEMENTED MAY 1980 VERSION OF STAGE I OF TAMU'S MULTIYEAR PROCEDURE (ITERATIVE WEIGHTED LEAST SQUARES ANALYSIS OF WORKING LOGIT)
  - Implemented on MTS
  - FORTRAN IV
  - IMSL Subroutine AGLMOD (General Linear Model Analysis)
- STUDIED IMPLEMENTATION OF STAGE II (WEIGHTED VARIANCE COMPONENT ESTIMATION)
  - The Fitting of Constants Methods (Henderson's Method 3)
  - Iterative Maximum Likihood Method
    - •• Requires initial estimates
    - •• Uses IMSL subroutine ZXMIN (minimum of a function of N variables using a quasi-newton method)
- STUDIED THE IMPACTS OF THE LIMITED DATA SET ON POSSIBLE EXPERIMENT DESIGNS

EVALUATION OF MULTIYEAR SAMPLING/ESTIMATION
IMPLEMENTATION LIMITATIONS

- NEED DEFINITIONS OF "EARLY", "MID", AND "AT HARVEST" FOR SEASON TERM IN MODEL
- NEED STOPPING RULE FOR ITERATIONS IN STAGE I
- NEED TO STUDY TAMU'S METHOD OF ESTIMATION OF VARIANCE COMPONENTS IN STAGE II
- NEED TO OBTAIN APU GROUND TRUTH FOR APU'S IN STUDY

MULTIYEAR SAMPLING/ESTIMATION

(constraints on design of the evaluation)

- MODEL $Y_{tsl} = \alpha_t + b_s + \delta_l + \epsilon_{tsl}$
- DATA
  - LACIE Segment Grain Segments
    - •• 1976, 1977, 1978
    - •• seasonal estimates made at various dates
    - •• ground truth
    - •• different procedures from year to year
  - USDA CRD and APU Unions of Counties
    - •• 1972 to 1976
    - •• 9 states in Northern and Southern Great Plains
- PROCEDURE yields estimates of α_t for each stratum

MULTIYEAR SAMPLING/ESTIMATION

EVALUATION DESIGN

- EXPERIMENTAL UNITS ARE MULTIYEAR LACIE SEGMENTS
- TREATMENTS
  - Multiyear Estimation of 1976 Grain Using 1976, 1977, 1978 Grain Estimates
  - One Year (1976) Grain Estimates
- ASSOCIATION BETWEEN EXPERIMENTAL UNITS AND TREATMENTS
  - Multiyear Estimates have Rotation Design Constraints
  - One Year Estimates Should have as Many 1976 Estimates as Possible
- MEASUREMENTS
  - Some Method of Deciding Which Method was Best for Each APU
- SIGN TEST

EVALUATION OF MULTIYEAR SAMPLING/ESTIMATION PLANS

- OBTAIN TEST CASE TO VERIFY STAGE I PROGRAMS
- IMPLEMENT FINAL VERSION OF TAMU'S STAGE I MULTIYEAR PROCEDURE
- IMPLEMENT TAMU'S STAGE II MULTIYEAR PROCEDURE
- FINALIZE EXPERIMENT DESIGN
- CONDUCT TEST AND EVALUATION

ERIM

CHANGE ANALYSIS

- OBJECTIVES
  - Obtain Increased Precision by Taking Advantage of Correlation Between Yearly Segment Proportion Estimates
  - Estimate Change Crop Proportion in Order to Study the Effect of Some Factor
    - •• Moisture stress
    - •• Economic conditions
    - •• Agronomic practices
- APPROACH
  - Estimate $R = \frac{P_{t_2}}{P_{t_1}}$ with $\hat{R}$
  - Estimate P_{t_2} with $\hat{R}P_{t_1}$

CHANGE ANALYSIS

- $\hat{R} = \exp(\bar{Y}_{t_2\cdot} - \bar{Y}_{t_1\cdot})$ where
  - $Y_{ts} = \log(\hat{P}_{ts})$ $\hat{P}_{ts}$ estimate for year t segment s
  - Motivation $\exp(\log(P_{t_2}) - \log(P_{t_1})) = \exp(\log(\frac{P_{t_2}}{P_{t_1}})) = \frac{P_{t_2}}{P_{t_1}}$
- $\hat{R} = \frac{\bar{P}_{t_2\cdot}}{\bar{P}_{t_1}}$
  - Best Linear Unbiased Estimate if
    - -- $P_{t_2 s} = BP_{t_1 s} + \epsilon_s$
    - -- Variance of $P_{t_2 s}$ is proportional to $P_{t_1 s}$
  - Generally Biased Estimate

CHANGE ANALYSIS
PLANS

- CONSTRUCT SIMULATED DATA SETS FOR EACH APU
  - Proportion grain from DATA
  - Proportion nonresponse from DATA
- ESTIMATE BIAS OF TWO ESTIMATES BY USING SIMULATED DATA
- INVESTIGATE THE USE OF COVARIATES AS MEASURES OF CHANGE
  - Weather data
  - Peak green of pixels labeled "pasture"
  - Machine grain labelers
  - Etc.

CORN AND SOYBEAN
CLASSIFICATION TECHNOLOGY DEVELOPMENT
FOR AREA ESTIMATION

FOR

FOREIGN COMMODITY PRODUCTION FORECASTING

ENVIRONMENTAL RESEARCH INSTITUTE OF MICHIGAN
UNIVERSITY OF CALIFORNIA AT BERKELEY
NASA, JOHNSON SPACE CENTER, SF4

FCPF SEMIANNUAL PROJECT REVIEW

24 SEPTEMBER 1980

FCPF C/S CLASSIFICATION TECHNOLOGY DEVELOPMENT FOR AREA ESTIMATION

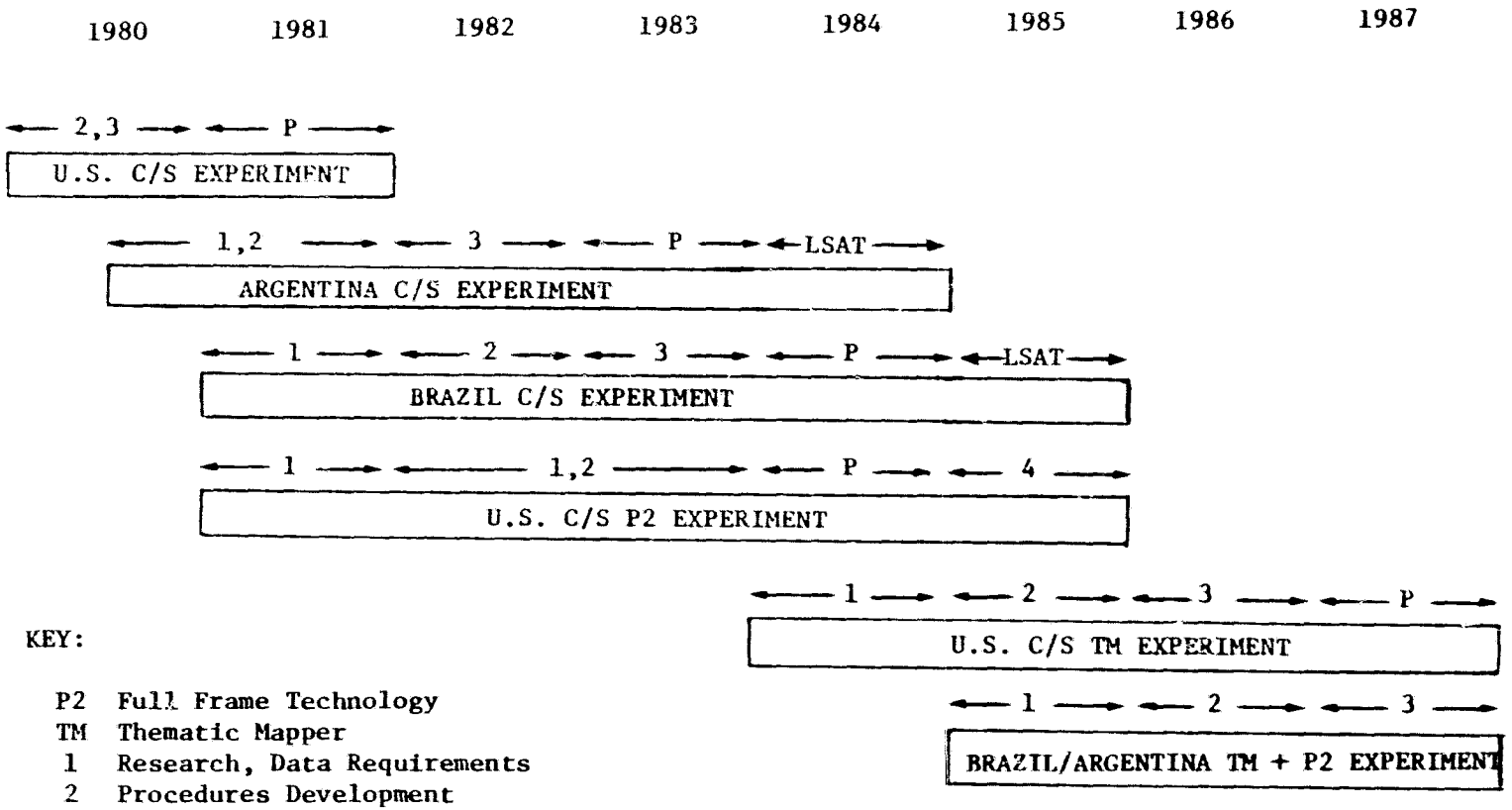
OBJECTIVES

- Conduct Foreign Exploratory Experiments in Area Estimation Technology for Corn and Soybeans in Support of Pilot Experiments
- Deliver Pilot-Compatible C/S Area Estimation Procedures
- Support Pilot

SCOPE OF FCPF RELATED PROGRAM

- IDENTIFY COMPONENT TECHNOLOGIES FOR CORN AND SOYBEAN AREA ESTIMATION
- ADAPT TECHNOLOGY TO FOREIGN APPLICATION
- DEVELOP END-TO-END PROCEDURES FOR EXPLORATORY EXPERIMENT TESTING
- IMPLEMENT PILOT-COMPATIBLE PROCEDURES FOR TEST AND EVALUATION
- COMPARATIVELY TEST AND EVALUATE TECHNOLOGIES
- SUPPORT SUBSEQUENT MODIFICATION AND PILOT TESTING

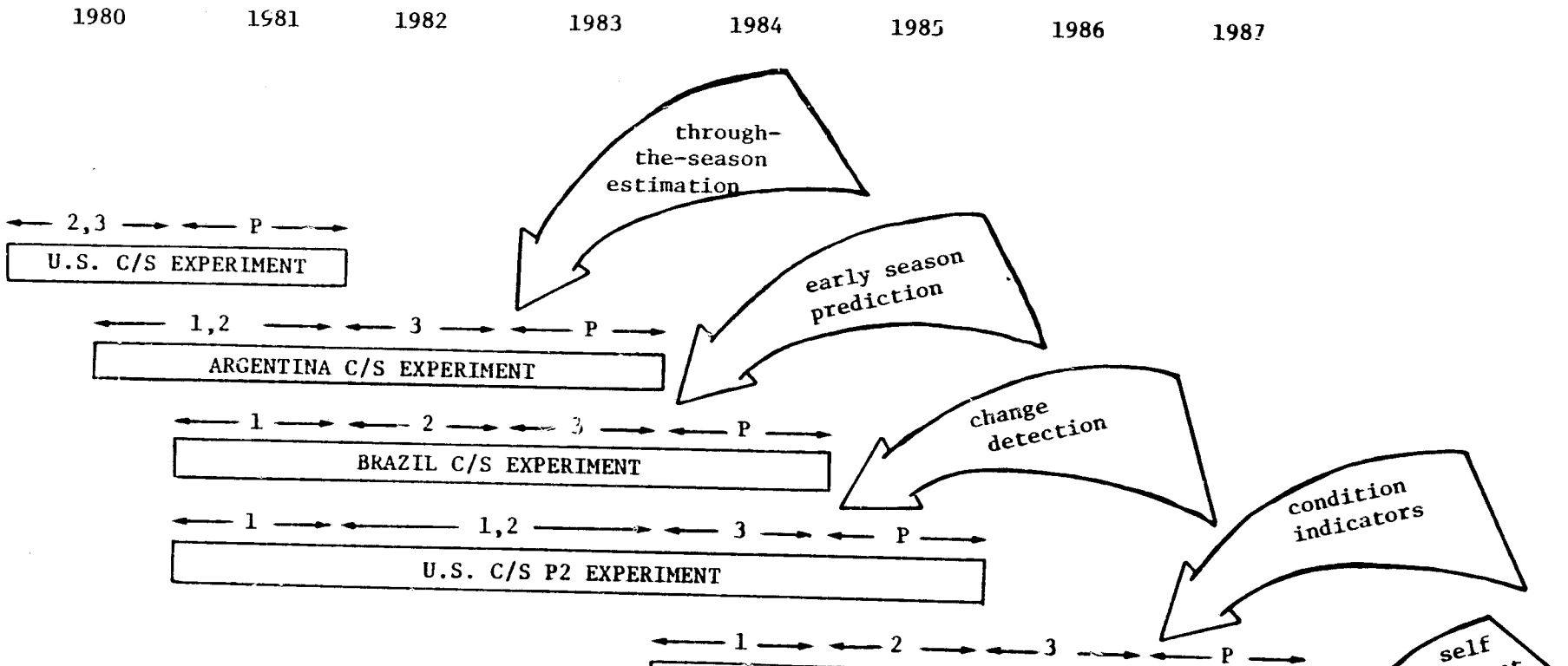
CORN AND SOYBEAN TECHNOLOGY PHASES



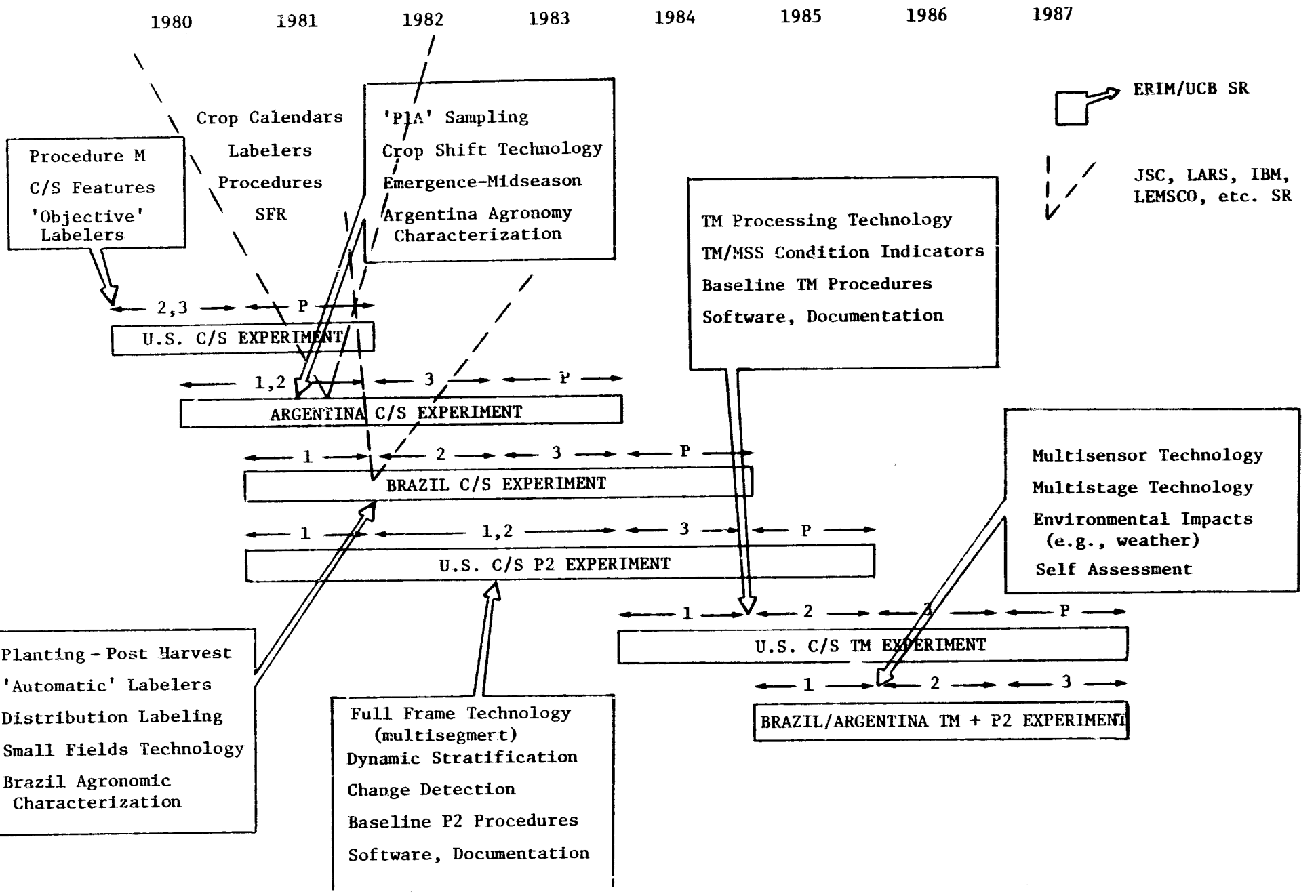
KEY:

P2	Full Frame Technology
TM	Thematic Mapper
1	Research, Data Requirements
2	Procedures Development
3	Procedures Evaluation, Modification
P	Pilot Experiment (JSC)
LSAT	Large Scale Application Test (USDA)

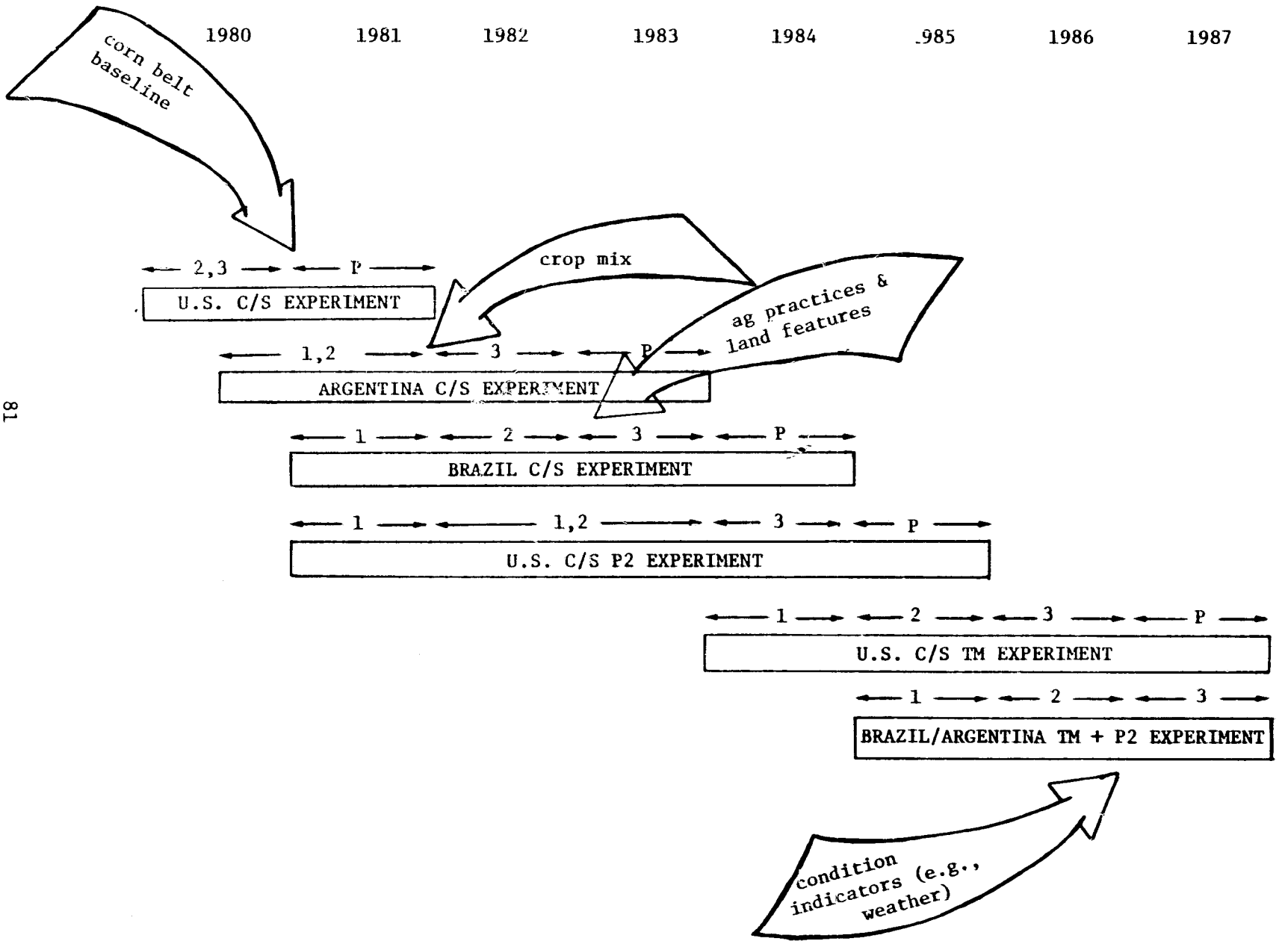
MULTIPURPOSE AGRICULTURE INVENTORY



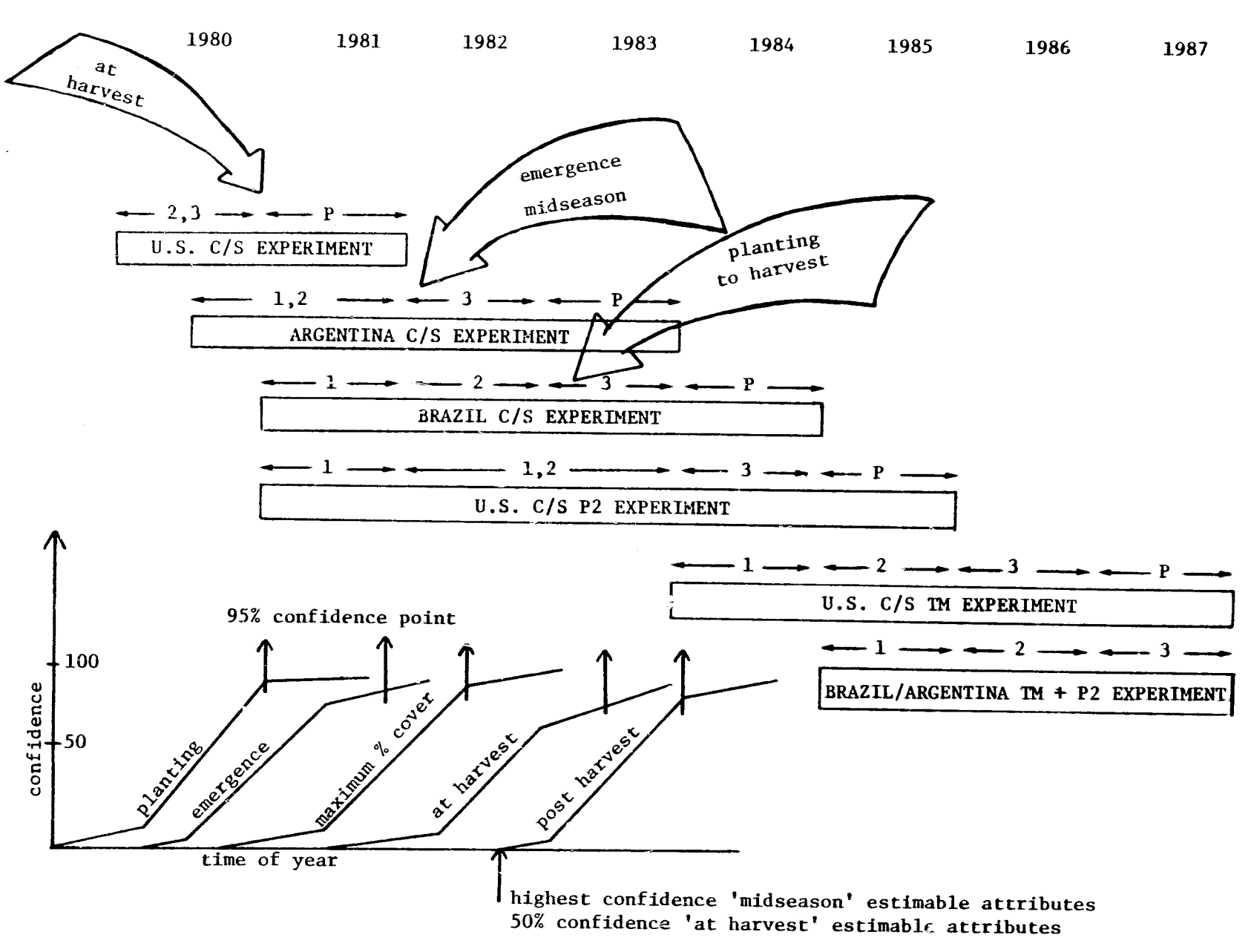
SUPPORTING RESEARCH FOR CORN AND SOYBEAN FOREIGN COMMODITY PRODUCTION FORECASTING



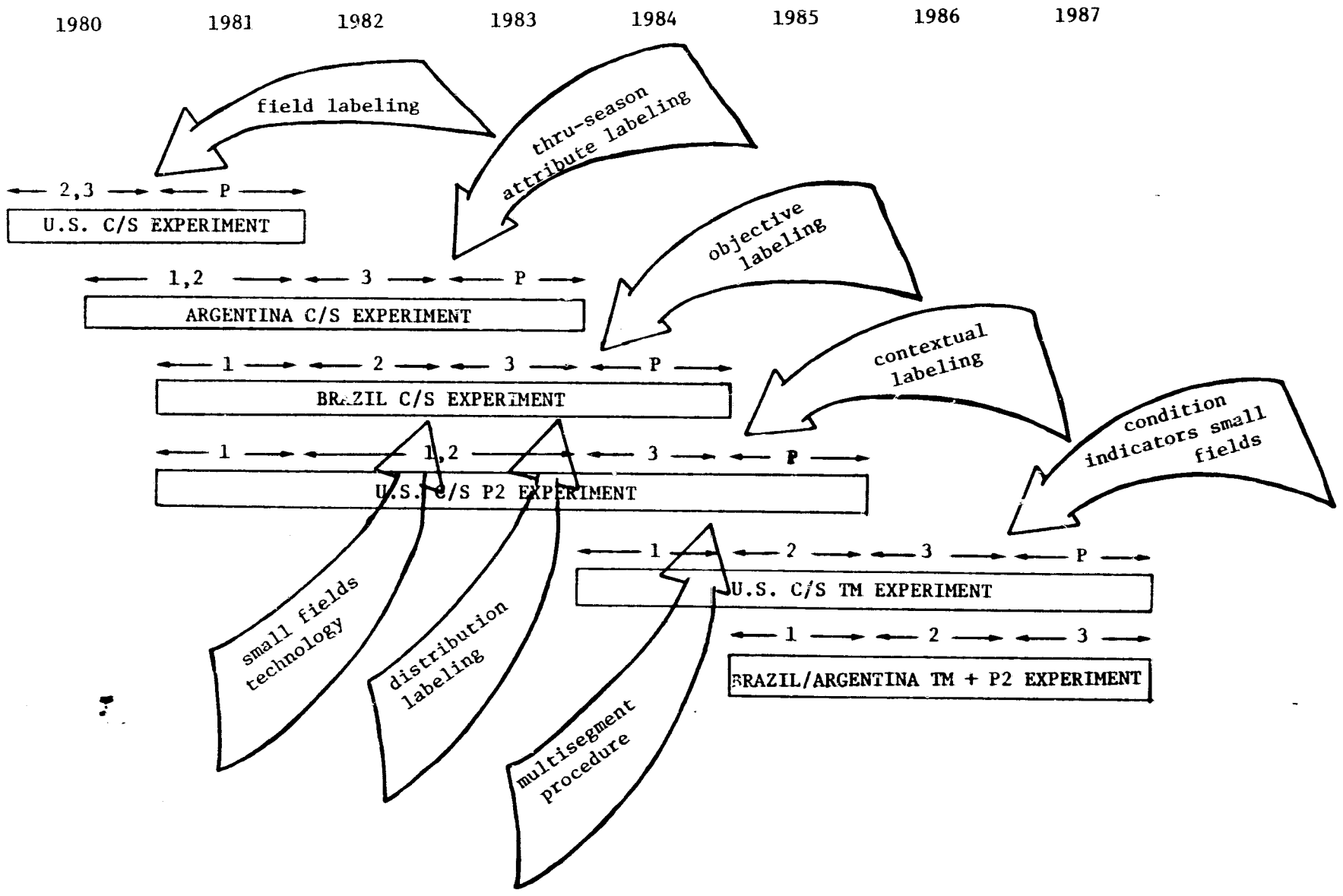
FOREIGN UNDERSTANDING



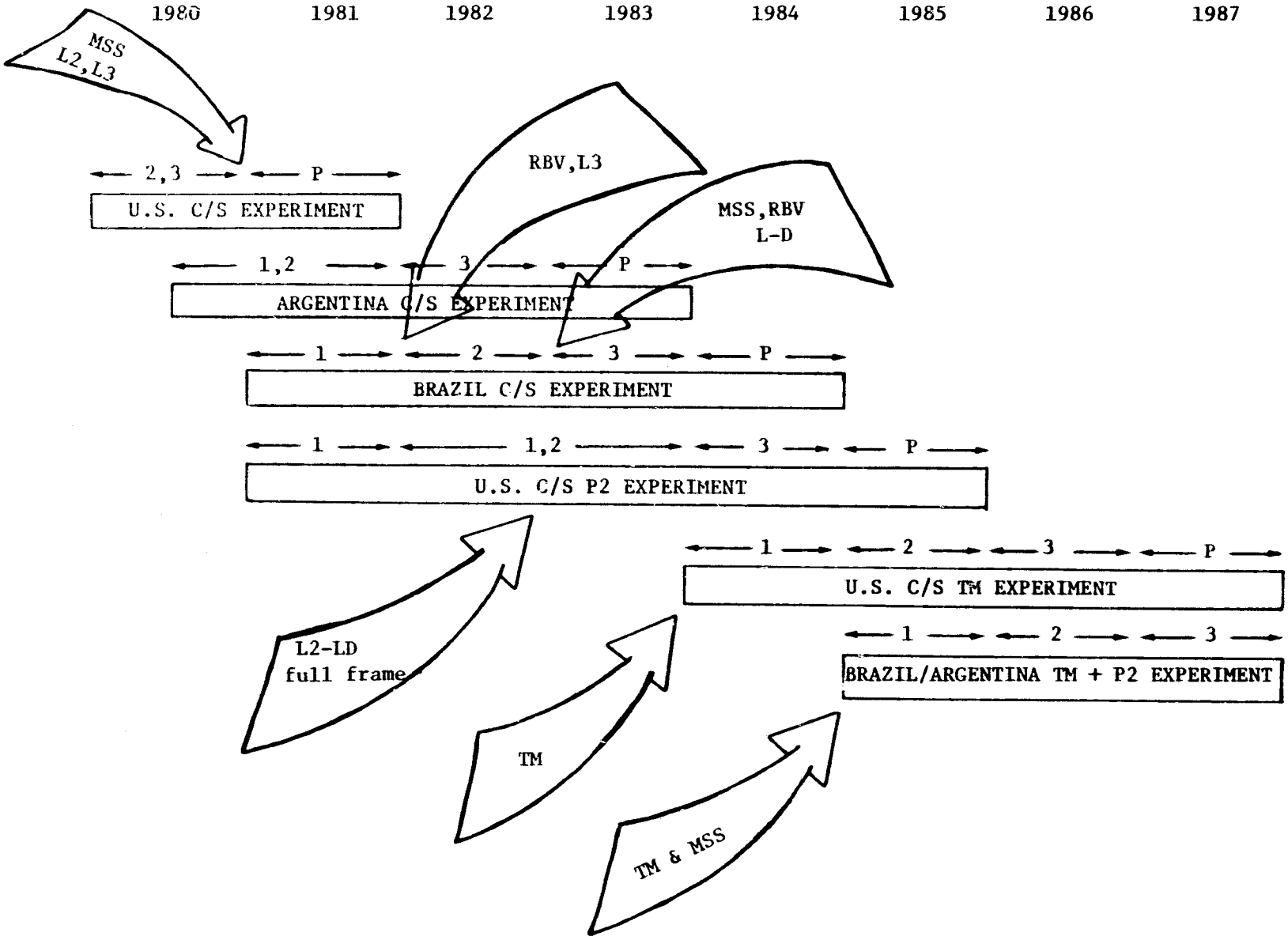
THROUGH-THE-SEASON ESTIMATION



CLASSIFICATION AND LABELING TECHNOLOGY



SENSOR TECHNOLOGY



TECHNOLOGY PHASE I

U.S. C/S CLASSIFICATION TECHNOLOGY DEVELOPMENT

TECHNICAL OBJECTIVE

- Develop and Implement Baseline Segment Classification Procedure for At-Harvest Estimates Suitable for Application in the U.S. Corn Belt

FY81 U.S. C/S PILOT IMPLEMENTATION APPROACH

- Overall Implementation Managed by ERIM
- Analyst Functions Integrated by UCB
- Software Development on LARS Computer Pending Availability of ERSYS at JSC
- Existing Technology Modified and Implemented
  - Procedure M tuned for Corn/Soybeans
  - JSC Labeling Procedure adapted to field-like targets rather than dots
  - Crop Group Stratification Integrating
    - Analyst
    - Crop Calendars
    - Machine

FCPF C/S CLASSIFICATION TECHNOLOGY DEVELOPMENT FOR AREA ESTIMATION*

PROJECT ELEMENT TASKS

	TASK	FISCAL YEAR	PERFORMING INSTITUTE
1.	US C/S AREA ESTIMATION PROCEDURE DESIGN	80	ERIM/UCB
2.	US C/S LABELING LOGIC DEVELOPMENT	80	UCB
3.	US C/S PROCEDURES IMPLEMENTATION	80/81	ERIM/UCB
4.	US C/S EXPLORATORY TEST AND EVALUATION	80	JSC/SF4
5.	US C/S CLASSIFICATION IN SUPPORT OF PILOT EXPERIMENT	81	JSC/SF4
6.	BRAZIL C/S AREA ESTIMATION PROCEDURE DESIGN	81	ERIM/UCB
7.	BRAZIL C/S LABELING LOGIC DEVELOPMENT	81	UCB
8	BRAZIL C/S PROCEDURES IMPLEMENTATION	81	ERIM/UCB
9	BRAZIL EXPLORATORY TEST AND EVALUATION	81	ERIM
10.	BRAZIL C/S CLASSIFICATION IN SUPPORT OF PILOT EXPERIMENT	82	JSC
11.	ARGENTINA C/S AREA ESTIMATION PROCEDURE DESIGN	81/82	ERIM/UCB
12.	ARGENTINA C/S LABELING LOGIC DEVELOPMENT	82	UCB/ERIM
13.	ARGENTINA C/S PROCEDURES IMPLEMENTATION	82	ERIM
14.	ARGENTINA C/S EXPLORATORY TEST AND EVALUATION	[illegible]	ERIM
15.	ARGENTINA C/S CLASSIFICATION IN SUPPORT OF PILOT EXPERIMENT	83	JSC

*Management Responsibility at ERIM

ACTIVITIES AND ACCOMPLISHMENTS

(14 FEB '80 - 24 SEP '80)

GENERAL

- INITIATED AND SUPPORTED PCR TO SWITCH ORDER FOR BRAZIL AND ARGENTINA FOREIGN APPLICATIONS
- SUPPORTED DEVELOPMENT OF DRAFT PLAN FOR COOPERATIVE RESEARCH PROGRAM WITH BRAZIL
- SUPPORTED REPLANNING BY FCPF IN ANTICIPATION OF
  - TWO YEAR DELAY IN TM DATA
  - ONE YEAR GAP IN MSS DATA (P2 EXP. DELAY)

ACTIVITIES AND ACCOMPLISHMENTS (CONTINUED)

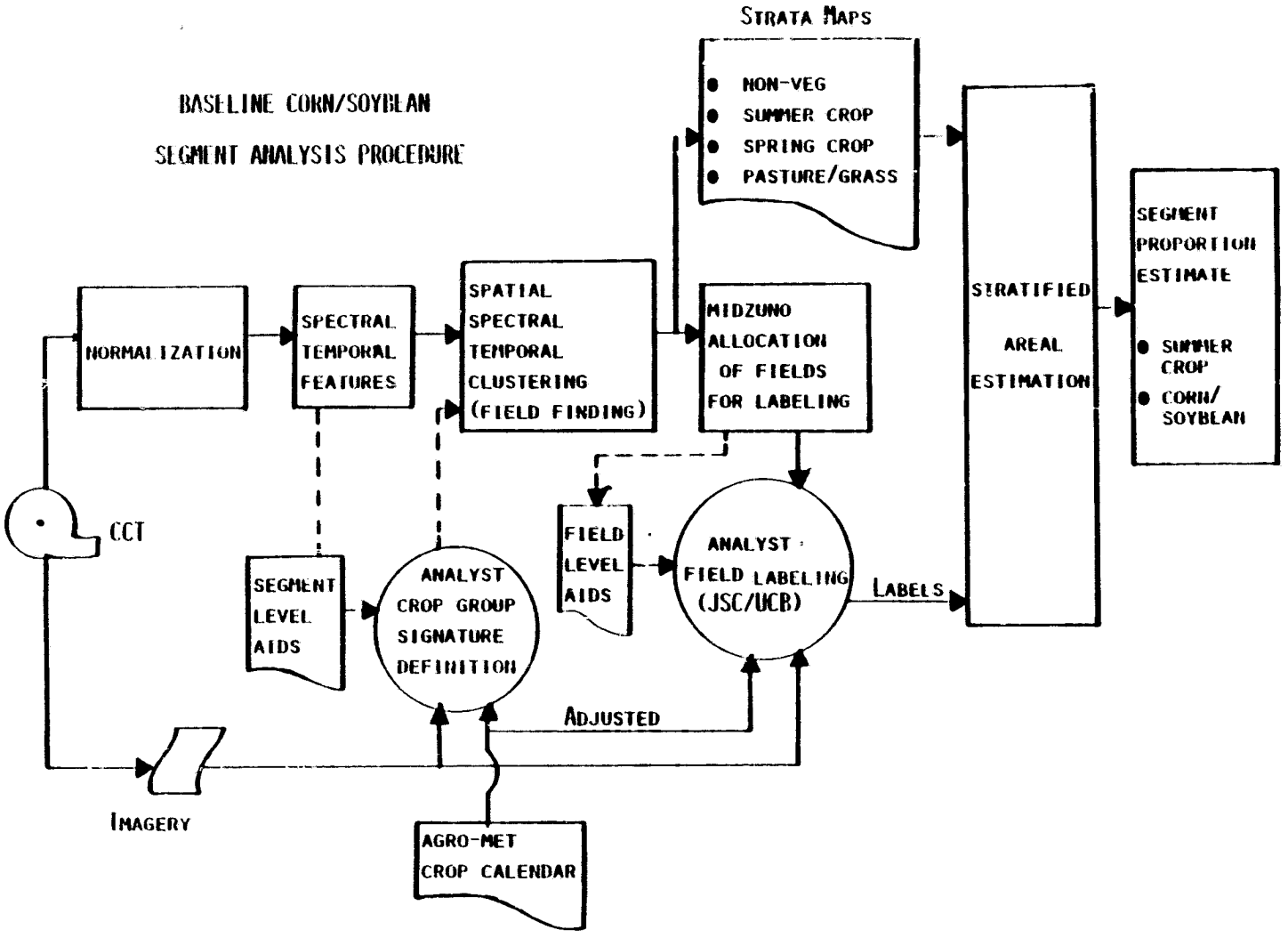
(14 FEB '80 - 24 SEP '80)

TASK 1: U.S. C/S AREA ESTIMATION PROCEDURE DESIGN

- FINALIZED C/S BASELINE PROCEDURE DESIGN AND COMPONENT SELECTION
- FINALIZED COMPONENT PARAMETER SPECIFICATION
- IDENTIFIED NEEDS FOR DEVELOPMENTAL DATA PRODUCTS FROM ACCURACY ASSESSMENT OF U.S. PILOT
- SPECIFIED COMPUTER REQUIREMENTS FOR IMPLEMENTATION

BASELINE CORN/SOYBEAN

SEGMENT ANALYSIS PROCEDURE



ACTIVITIES AND ACCOMPLISHMENTS (CONTINUED)

(14 FEB '80 - 24 SEP '80)

TASK 2: U.S. C/S LABELING LOGIC DEVELOPMENT

- DEFINED CONTENTS/FORMAT FOR AI PACKET
- DEFINED REQUIREMENTS FOR CROP CALENDAR/WEATHER INTERPRETATION
- DEFINED REQUIREMENTS FOR MACHINE-GENERATED AI AIDS
- DEFINED COMPONENT PROCEDURES
  - ACQUISITION SELECTION
  - CROP GROUP STRATIFICATION (DFS)
  - LABELING LOGIC
- DEFINED OVERALL MANUAL PROCEDURE

ACTIVITIES AND ACCOMPLISHMENTS (CONTINUED)

(14 FEB '80 - 24 SEP '80)

TASK 3: U.S. C/S PROCEDURES IMPLEMENTATION

- IMPLEMENTED AN ERSYS-INDEPENDENT IMPLEMENTATION APPROACH
- COMPLETED CODING AND VALIDATION OF SYSTEM SERVICES
- COMPLETED CODING AND VALIDATION OF SCENARIOS AND APPLICATION MODULES (EXCEPT AI AIDS)
- DESIGNED PILOT USERS MANUAL AND INITIATED PREPARATION OF DOCUMENTATION (MACHINE AND MANUAL PROCEDURES)
- INITIATED DEVELOPMENT OF AI TRAINING METHODOLOGY

ACTIVITIES AND ACCOMPLISHMENTS (CONTINUED)

(14 FEB '80 - 24 SEP '80)

TASK 4: U.S. C/S EXPLORATORY TEST AND EVALUATION

- CONDUCTED FAMILIARIZATION TRAINING OF JSC ANALYSTS IN U.S. C/S PILOT ANALYST PROCEDURES

- SUPPORTED PROCEDURES SHAKEDOWN TEST AND EVALUATION

ACTIVITIES AND ACCOMPLISHMENTS (CONTINUED)

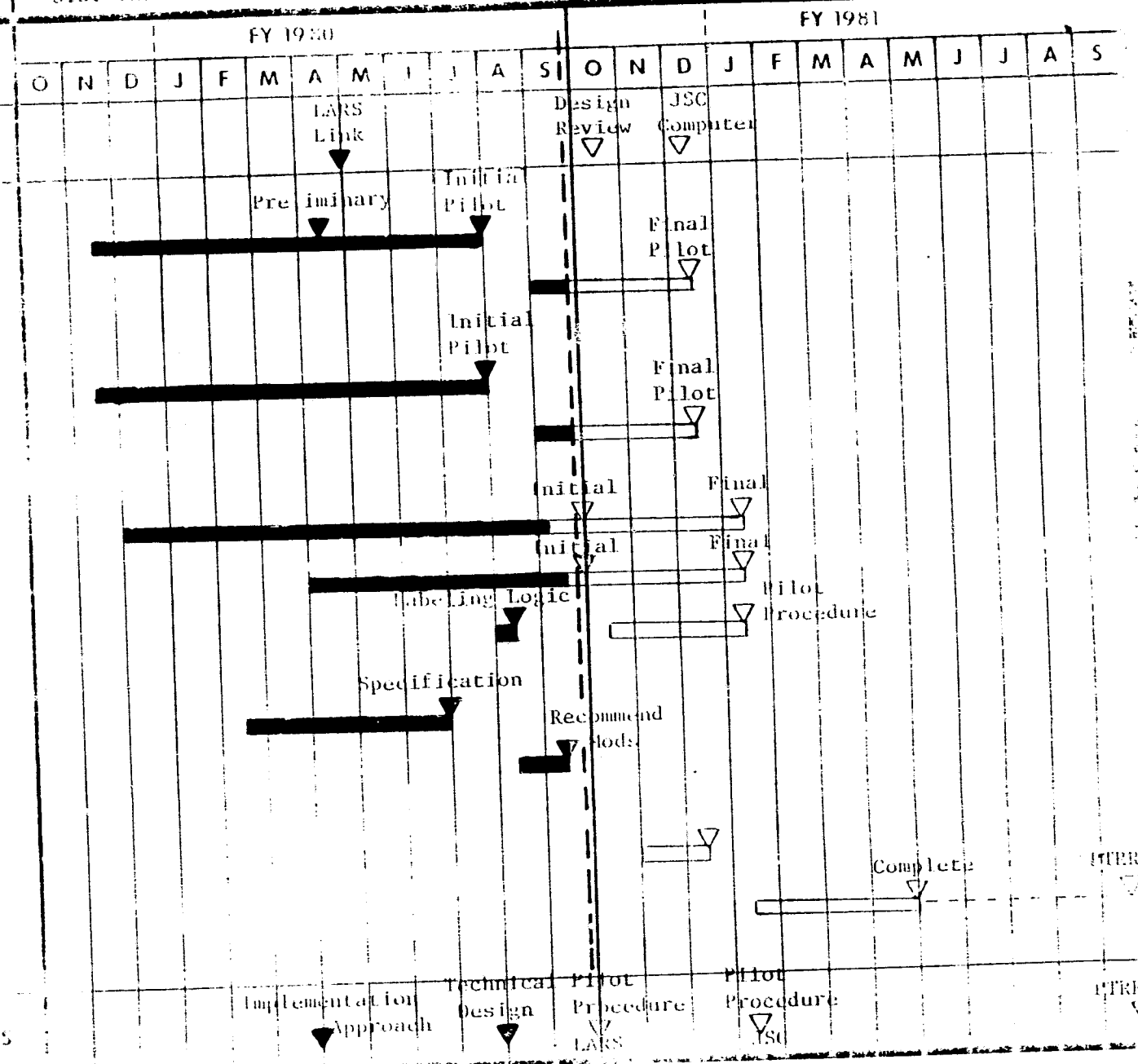
(14 FEB '80 - 24 SEP '80)

TASK 5: U.S. C/S CLASSIFICATION IN SUPPORT OF PILOT EXPERIMENT

- IDENTIFIED CANDIDATE PILOT EVALUATION FACTORS TO EXPERIMENT DESIGN
- IDENTIFIED CANDIDATE PILOT PRODUCTS TO ACCURACY ASSESSMENT
- IDENTIFIED NATURE OF SEGMENT ESTIMATES TO SAMPLING AND AGGREGATION
- PROVIDED GENERAL SUPPORT TO ABOVE PROJECT ELEMENTS

REPORTING ORG./ACTIVITY: C/S CLASSIFICATION TECHNOLOGY FOR AREA ESTIMATION
U.S. TECHNOLOGY PHASE 1

DATE 09/22/80
PAGE 1 OF 1



NEAR TERM PLANS

(24 SEP '80 - 15 DEC '80)

GENERAL

- DEVELOP DETAILED IMPLEMENTATION PLAN FOR FY81 - FY82
- SUPPORT U.S. PILOT EXPERIMENT
  - SUPPORT CRITICAL DESIGN REVIEW OF BASELINE PROCEDURE
  - COMPLETE IMPLEMENTATION AND DOCUMENTATION
  - PROVIDE TRAINING AND SUPPORT SHAKEDOWN
  - MODIFY DOCUMENTATION AND PROCEDURES WHERE NECESSARY
- INITIATE CORN AND SOYBEAN TECHNOLOGY PHASE 2

TECHNOLOGY PHASE II

ARGENTINA C/S CLASSIFICATION TECHNOLOGY DEVELOPMENT

- DEVELOP, IMPLEMENT AND EVALUATE SEGMENT CLASSIFICATION PROCEDURES FOR THROUGH-THE-SEASON ESTIMATES (EMERGENCE TO HARVEST) SUITABLE FOR APPLICATION IN ARGENTINA

FCPF C/S CLASSIFICATION TECHNOLOGY DEVELOPMENT FOR AREA ESTIMATION

PLANNING UNCERTAINTIES

- NATURE OF EXPERIMENT DESIGN AND ACCURACY ASSESSMENT INTERFACES FOR ERIM-CONDUCTED EXPLORATORY T&E'S

- DEGREE AND NATURE OF ERIM INVOLVEMENT IN NASA/INPE RESEARCH AGREEMENT

FCPF C/S CLASSIFICATION TECHNOLOGY DEVELOPMENT FOR AREA ESTIMATION

ISSUES

MSS DATA PROVISIONING

DOES NOT APPEAR TO SUPPORT

CURRENT FY81 SCHEDULES

ACTIVITIES AND ACCOMPLISHMENTS

In Support Of

SUPPORTING RESEARCH PROJECT

Environmental Research Institute of Michigan
University of California at Berkley

SR Semiannual Project Review

7 October 1980

PRESENTATION OUTLINE

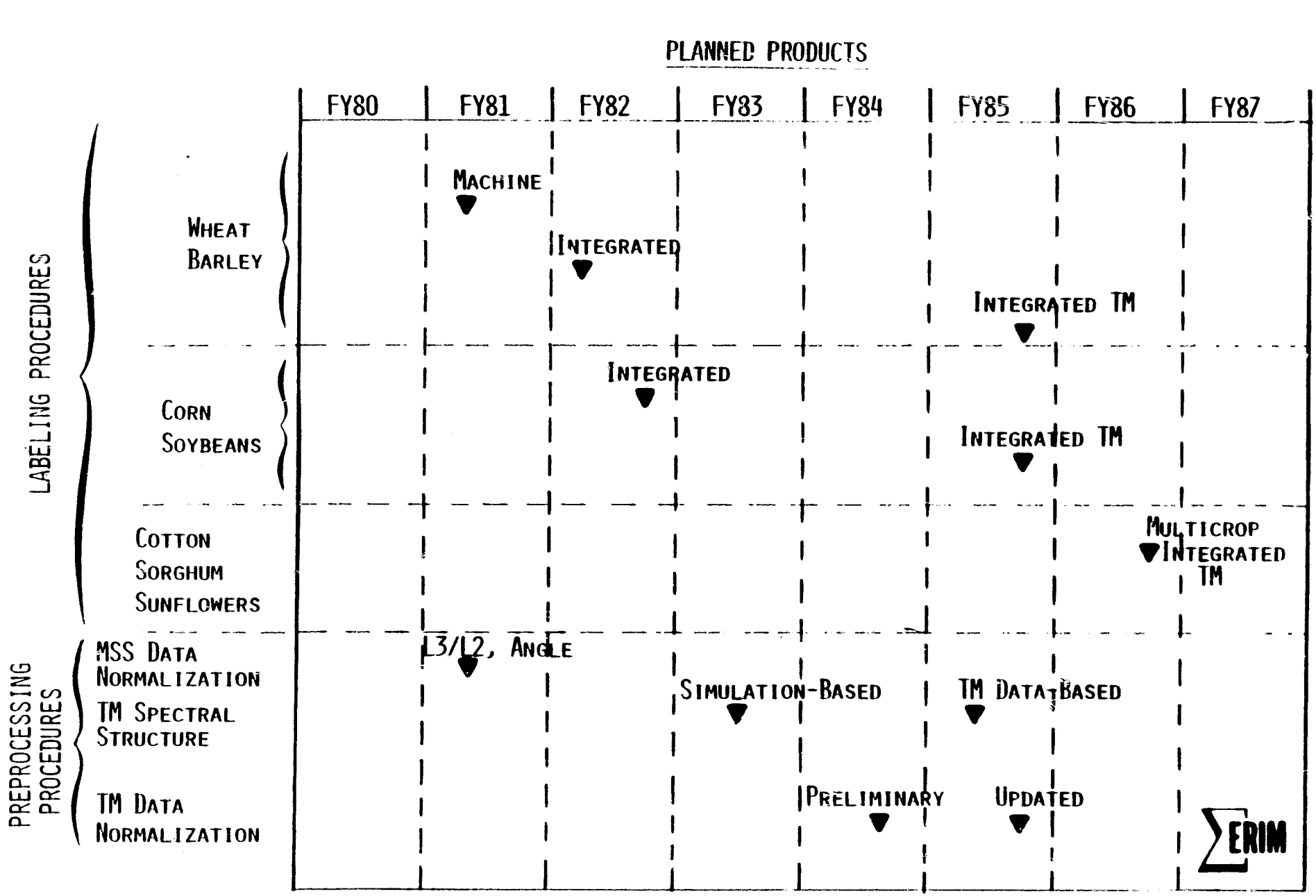
- Objective Labeling Technology Development (ERIM)
- Corn and Soybeans Classification Technology Development for Area Estimation (ERIM/UCB)

OBJECTIVE LABELING TECHNOLOGY DEVELOPMENT

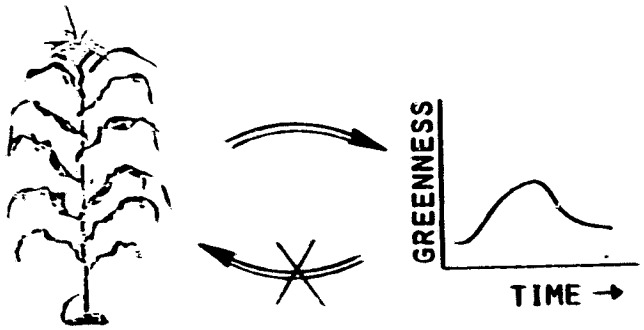
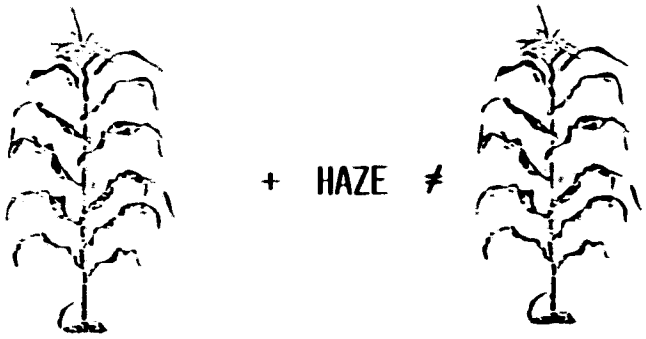
OBJECTIVES

- OVERALL:
  - To Develop a Series of Candidate Labeling Procedures for Test and Evaluation in Exploratory and Pilot Experiments Within SR and FCPF. These procedures Should Be:
    - OBJECTIVE
    - ACCURATE
    - ADAPTABLE
- SPECIFIC:
  - To Develop an End-of-Season Labeling Procedure for Spring Wheat Which is Machine-Oriented and Utilizes Temporal-Spectral Profile Analysis Technology.
  - To Develop Tools for Continued Research and Development of Labeling Procedures.

OBJECTIVE LABELING TECHNOLOGY DEVELOPMENT



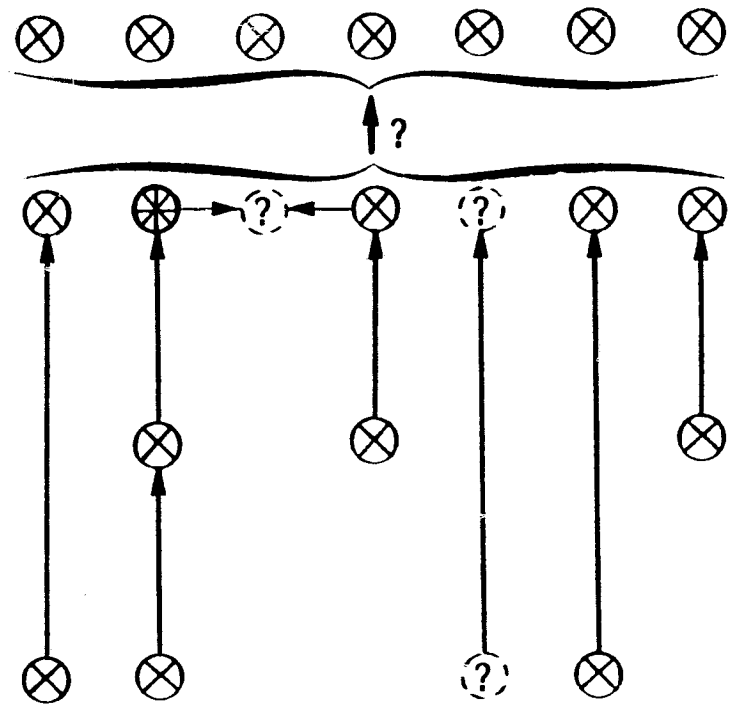
OBJECTIVE TABLE

CONCEPT	CONCLUSION
	- TECHNOLOGY DEVELOPMENT REQUIRES MORE THAN LANDSAT OBSERVATIONS - INDEPENDENTLY UNDERSTAND AGROPHYSICS AND LANDSAT - LANDSAT, FIELD RESEARCH, PHYSICAL MODELING
	- LANDSAT PROVIDES MORE INFORMATION THAN WE WANT - UNINTERESTING PHYSICAL PHENOMENA MUST BE UNDERSTOOD
CROP ⟹ OBSERVATION ⟹ CROP ?	- UNLIKELY THAT DESIRED INFORMATION OBSERVABLE
CROP ⟹ OBSERVATION ⟹ ROW CROP	- ANTICIPATE LOWER LEVEL FEATURES OBSERVABLE

ERIM

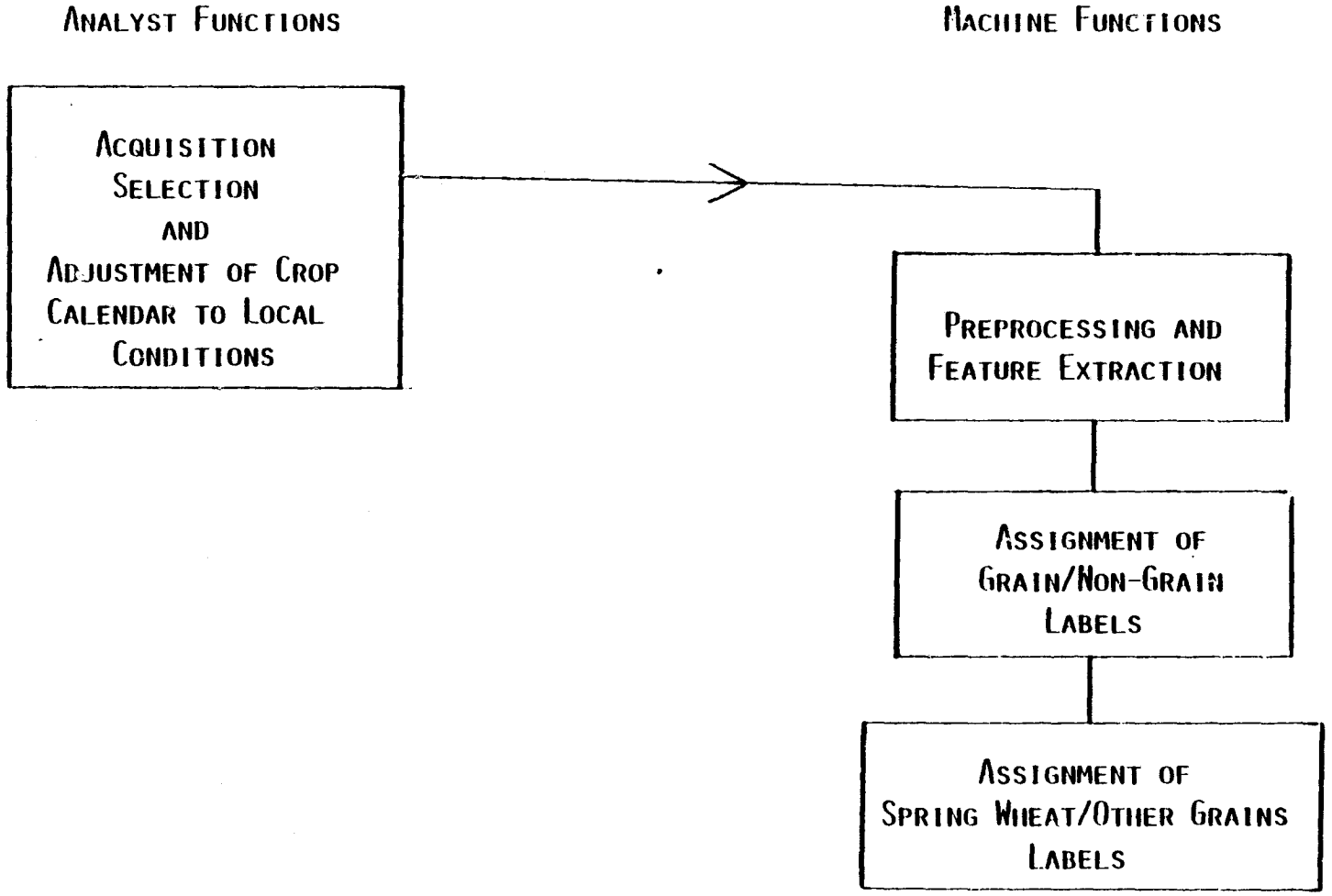
AGROPHYSICAL SIGNATURE APPROACH

INFORMATION SOURCE	AGROPHYSICAL DESCRIPTORS (A FARMER WOULD UNDERSTAND)
GROUND OBSERVABLE SIGNATURE	
INFORMATION AVAILABLE THROUGH JOINT ANALYSIS AND CONSTRAINTS	
COLLATERAL PREDICTABLE (WEATHER, PRACTICE, ECONOMICS, POLITICS)	
LANDSAT OBSERVABLE (MSS, RBV, TM)	



ERIM

BLOCK DIAGRAM
MACHINE-ORIENTED LABELING PROCEDURE FOR SPRING WHEAT

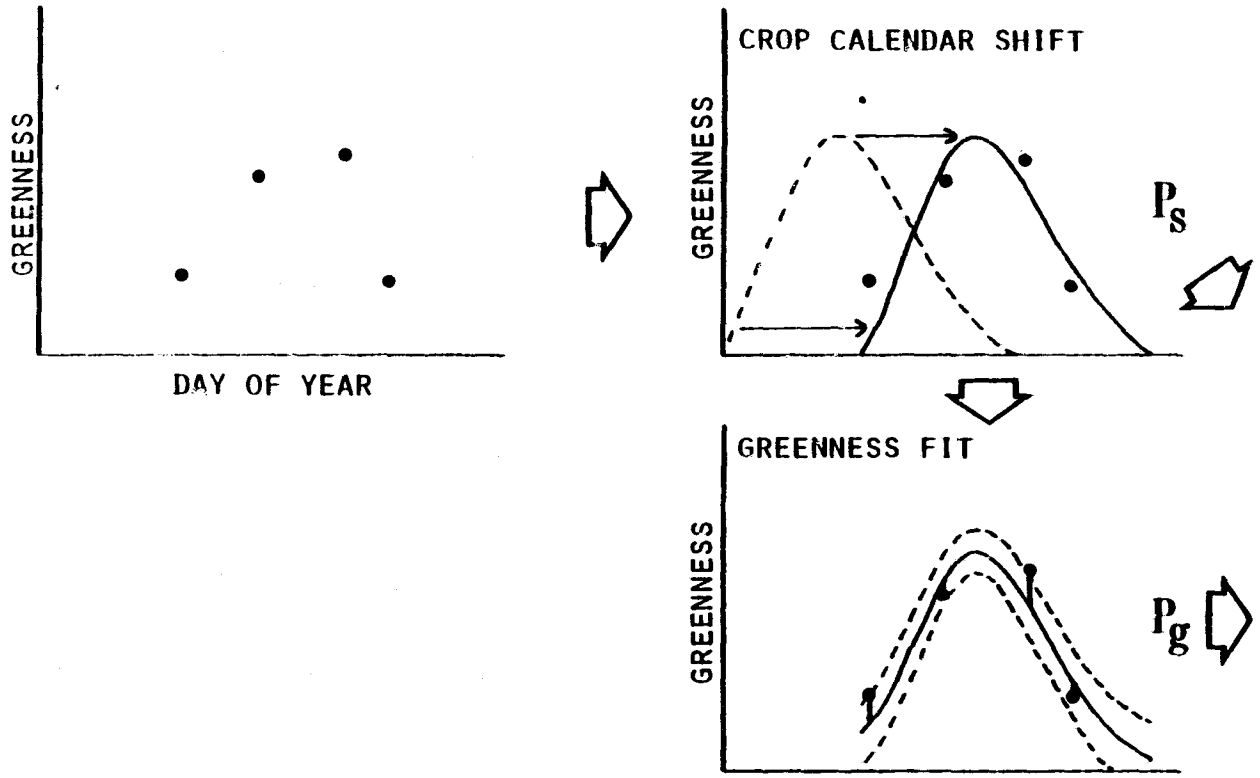


ERIM

BLOB MEAN VECTOR

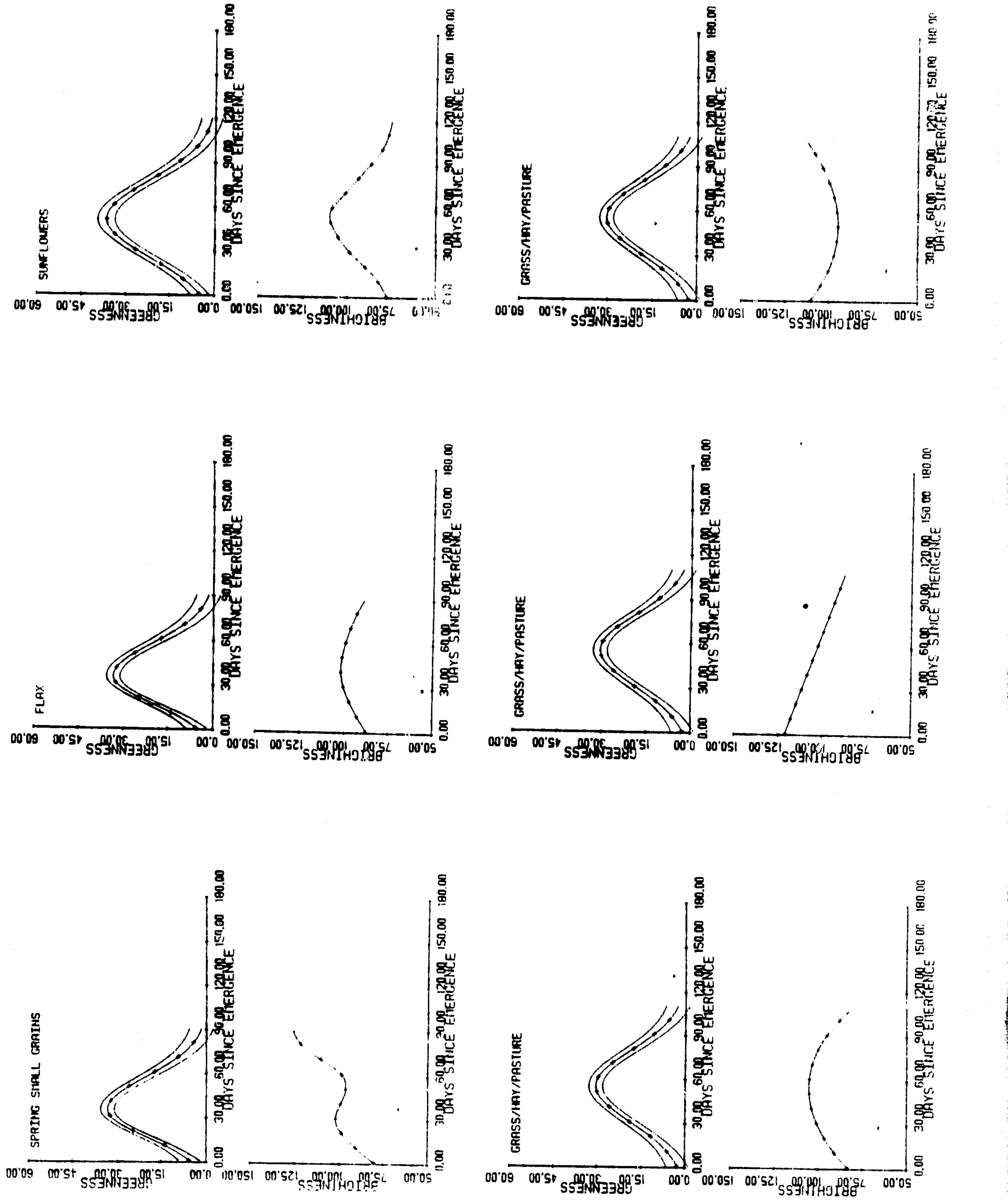
COMPARED TO PROFILES FOR EACH CROP i

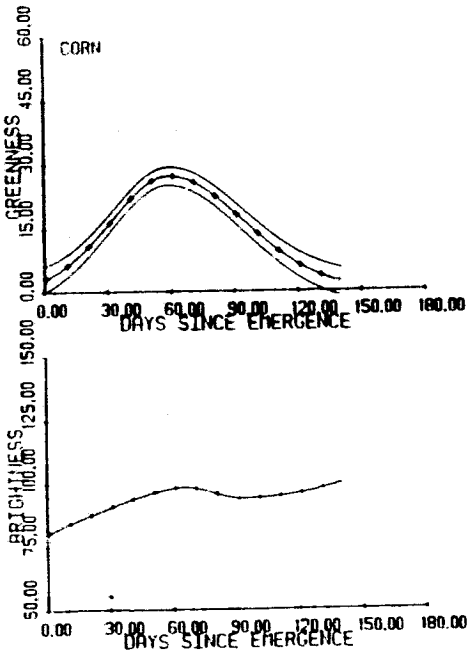
COMBINED PROBABILITY COMPUTED

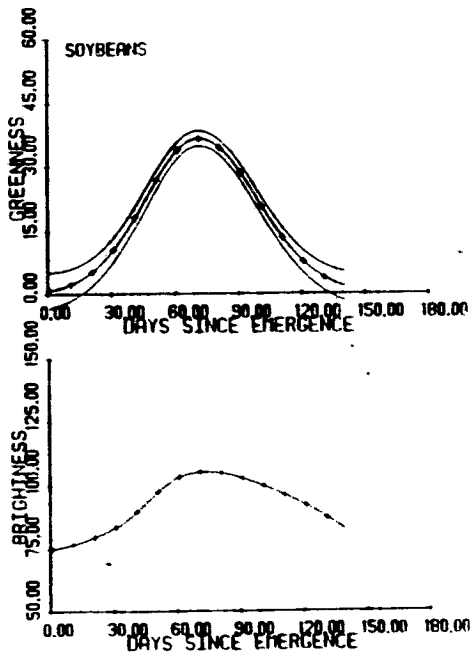


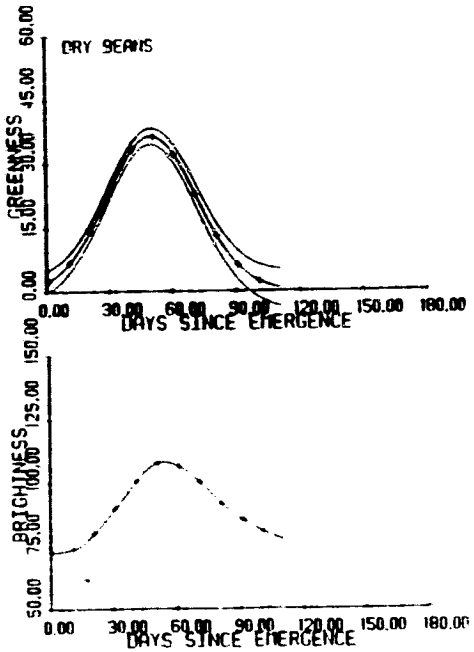
$$P_i = F(P_s, P_g, P_b)$$

ERIM


SUNFLOWERS
FLAX
SPRING SMALL GRAINS
GRASS/HAY/PASTURE
GRASS/HAY/PASTURE
GRASS/HAY/PASTURE
GREENNESS
BRIGHTNESS
DAYS SINCE EMERGENCE


CORN
GREENNESS
0.00
15.00
30.00
45.00
60.00
0.00
30.00
60.00
90.00
120.00
150.00
180.00
DAYS SINCE EMERGENCE
BRIGHTNESS
50.00
75.00
100.00
125.00
150.00
0.00
30.00
60.00
90.00
120.00
150.00
180.00
DAYS SINCE EMERGENCE


SOYBEANS
GREENNESS
0.00
15.00
30.00
45.00
60.00
0.00
30.00
60.00
90.00
120.00
150.00
180.00
DAYS SINCE EMERGENCE
BRIGHTNESS
50.00
75.00
100.00
125.00
150.00
0.00
30.00
60.00
90.00
120.00
150.00
180.00
DAYS SINCE EMERGENCE


DRY BEANS
GREENNESS
0.00
15.00
30.00
45.00
60.00
0.00
30.00
60.00
90.00
120.00
150.00
180.00
DAYS SINCE EMERGENCE
BRIGHTNESS
50.00
75.00
100.00
125.00
150.00
0.00
30.00
60.00
90.00
120.00
150.00
180.00
DAYS SINCE EMERGENCE

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PRELIMINARY TEST OF MODIFIED, 2-CLASS VERSION OF PROCEDURE

DATA: 26 SEGMENTS, 3 YEARS (SAME DATA USED FOR DEVELOPMENT)

FEATURE: TEST STATISTIC CONSISTING OF WEIGHTED SUM OF PROBABILITIES

- Fit to Grain GREENNESS Profile
- Cross-Correlation with Grain BRIGHTNESS Profile
- Deviation from Mean Shift of Grain Blobs to Grain Profile

DECISION MECHANISM: OPTIMUM LINEAR DISCRIMINANT

RESULT: 78% OF GRAIN BLOBS CORRECTLY CLASSIFIED

81% OF NON-GRAIN BLOBS CORRECTLY CLASSIFIED

FLAX FELL 50% IN EACH CLASS

PRELIMINARY FEATURE WEIGHTS

- 3 for Crop Calendar Shift
- 2 for Brightness Fit
- 1 for Greenness Fit

MACHINE-ORIENTED SPRING WHEAT LABELLER

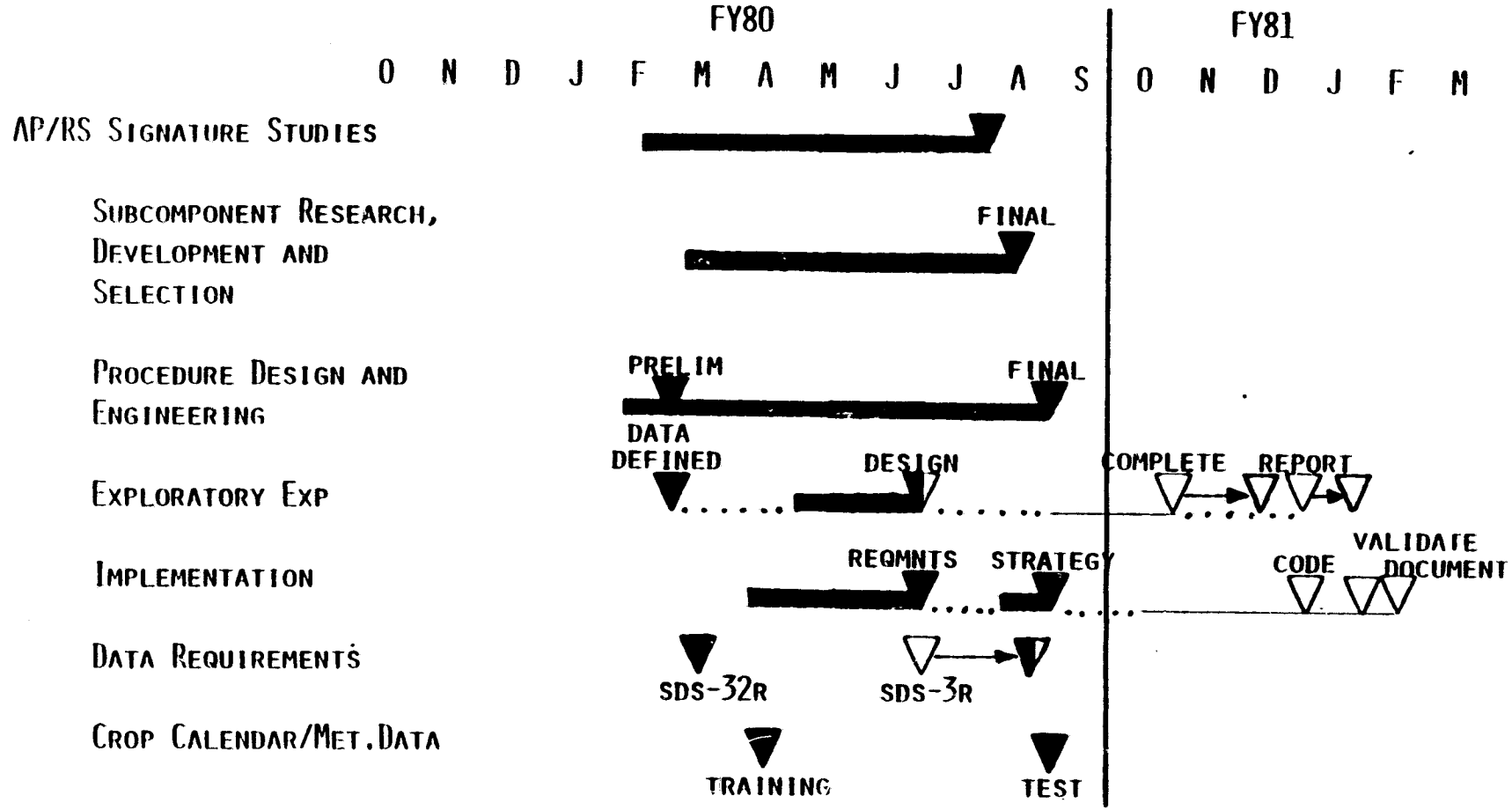
CHARACTERISTICS OF LABELS

- End of Season

- Spring Small Grains vs Other
  - Absolute probability/confidence that it is a crop
  - Relative probability that it is each of seven crops (SSG, Flax, Sunflowers, Grass/Hay/Pasture, Corn, Soybeans, Dry Beans)

- Spring Wheat/Barley
  - Binary decision (per pixel) among SSG labels

MACHINE-ORIENTED LABELING PROCEDURE FOR SPRING WHEAT



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OBJECTIVE LABELING TECHNOLOGY DEVELOPMENT

ACCOMPLISHMENTS

(15 Feb 80 - 7 Oct 80)

- MACHINE-ORIENTED SPRING WHEAT LABELER
  - Design Completed
  - Preliminary Parameters Defined
  - Experiment Designed for Final Parameter Selection
- GENERIC LABELING TECHNOLOGY
  - Spectral/Temporal Characterization of Seven Crops (SSG Labeling Context)
  - Implemented 1980 Ritchie Wheat Growth Model
  - Initiated Characterization of Generic Decision Processes
  - Established Labeling Data Base (> 11,000 GT Pure Pixel Fields/3 years/7 crops)
  - Delivered Crop Calender Shift Algorithms (SSG)

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ACCOMPLISHMENTS (Continued)

(15 Feb 80 - 7 Oct 80)

- PREPROCESSING IN SUPPORT OF LABELING
  - Initiated Effort To Develop/Deliver
    - -- Initial scan angle normalization procedure
    - -- Revised L3 → L2 calibration procedure

ERIM

OBJECTIVE LABELING TECHNOLOGY DEVELOPMENT

NEAR TERM PLANS/MILESTONES

- MACHINE-ORIENTED SPRING WHEAT LABELER
  - Developmental Exploratory Experiment (1 Dec 80)
  - Technology Report (15 Jan 81)
  - Delivery onto JSC Computer (15 Feb 81)
- GENERIC LABELING TECHNOLOGY
  - Characterization of Generic Decision Processes (1 Mar 81)
  - Initial Wheat Seed-to-Satellite Model (1 May 81)
  - Preliminary Optimal Machine/Analyst Integration (1 Jun 81)
  - Continued Spectral/Temporal Crop Characterization
  - Continued Data Base Development

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NEAR TERM PLANS/MILESTONES (Continued)

- PREPROCESSING IN SUPPORT OF LABELING
  - Scan Angle and L3/L2 Normalization Procedures (15 Jan 81)

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CORN AND SOYBEAN

CLASSIFICATION TECHNOLOGY DEVELOPMENT

FOR AREA ESTIMATION

FOR

SUPPORTING RESEARCH PROJECT

ENVIRONMENTAL RESEARCH INSTITUTE OF MICHIGAN

UNIVERSITY OF CALIFORNIA AT BERKELEY

SR SEMIANNUAL PROJECT REVIEW

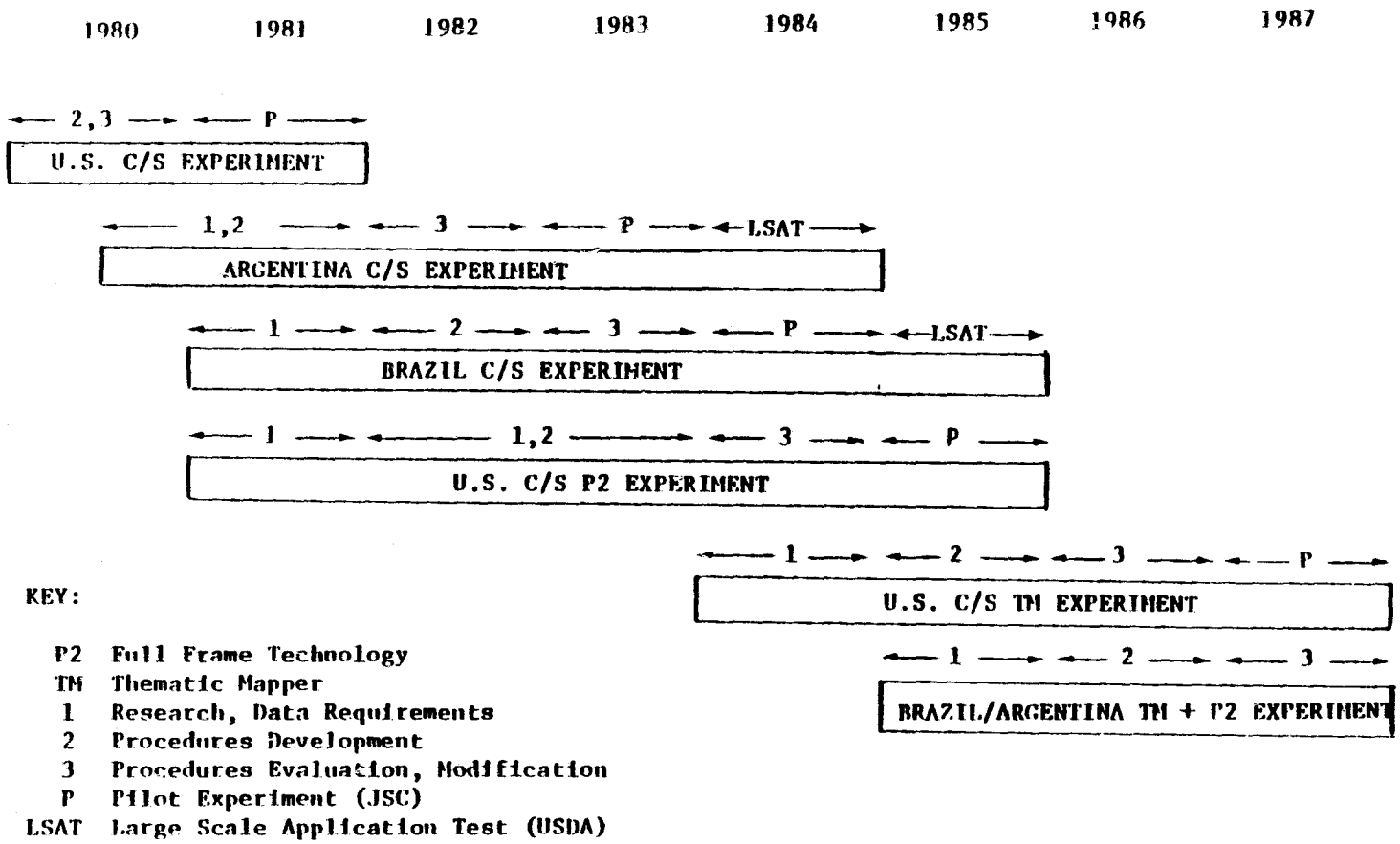
7 OCTOBER 1980

SR C/S CLASSIFICATION TECHNOLOGY DEVELOPMENT FOR AREA ESTIMATION

OBJECTIVES

- RESEARCH AND DEVELOP GENERIC C/S CLASSIFICATION TECHNOLOGIES ADAPTABLE (BY FCPF) TO FOREIGN REGIONS
- CONDUCT U.S. C/S EXPLORATORY EXPERIMENTS IN ADVANCED CLASSIFICATION TECHNOLOGY (P2,TM)
- DELIVER PILOT-COMPATIBLE ADVANCED C/S CLASSIFICATION TECHNOLOGY TO FCPF

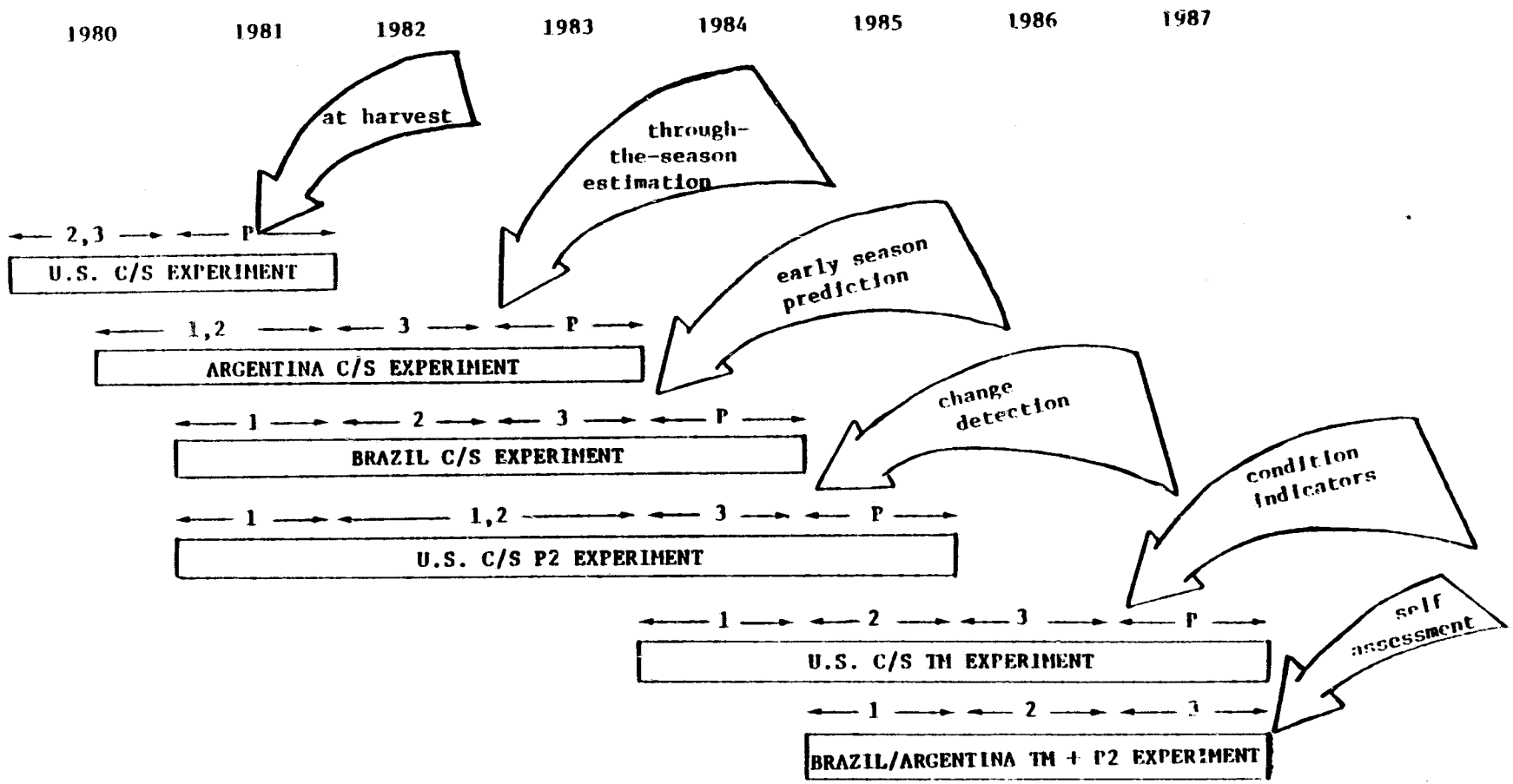
CORN AND SOYBEAN TECHNOLOGY PHASES



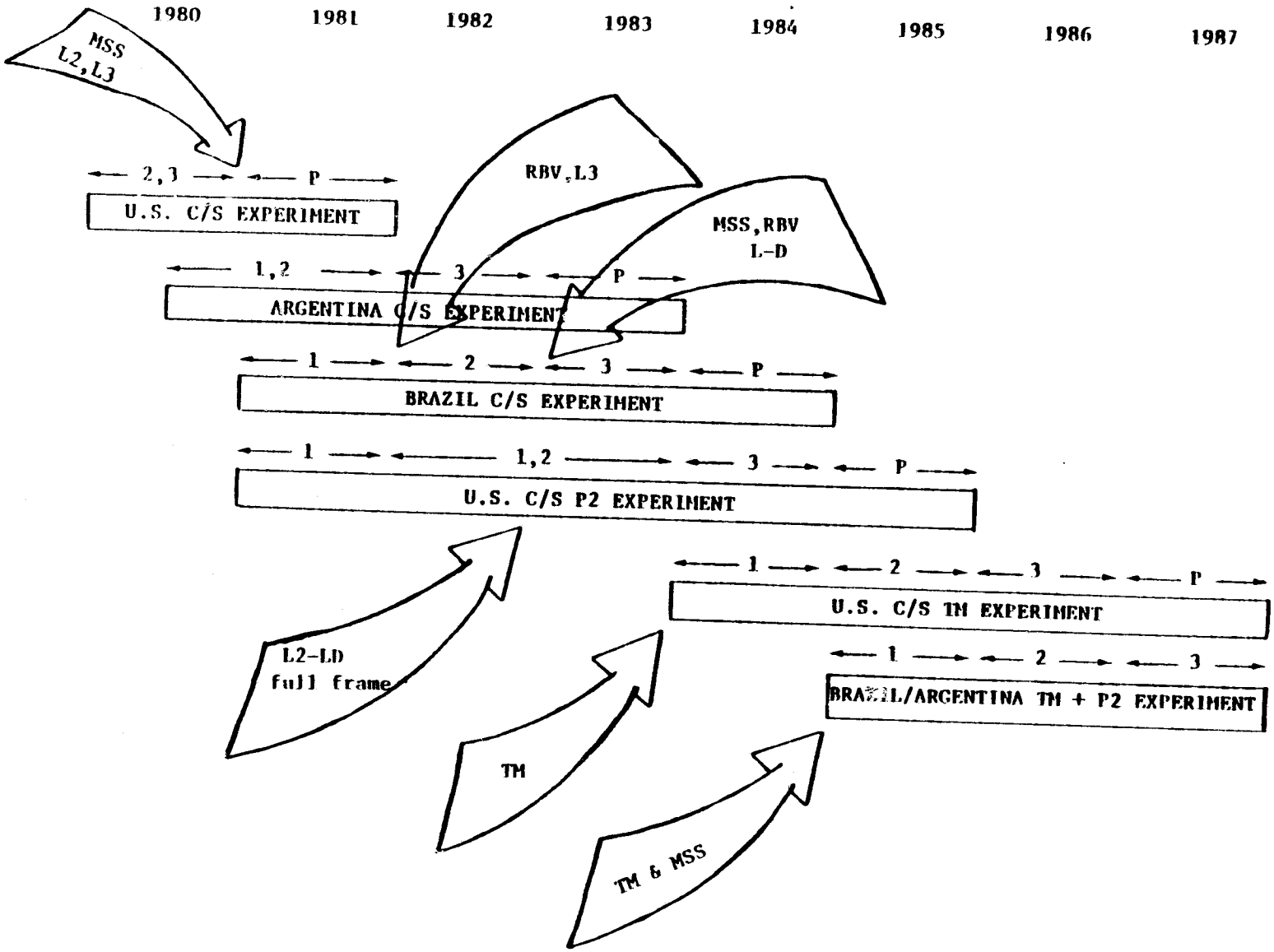
KEY:

P2	Full Frame Technology
TM	Thematic Mapper
1	Research, Data Requirements
2	Procedures Development
3	Procedures Evaluation, Modification
P	Pilot Experiment (JSC)
LSAT	Large Scale Application Test (USDA)

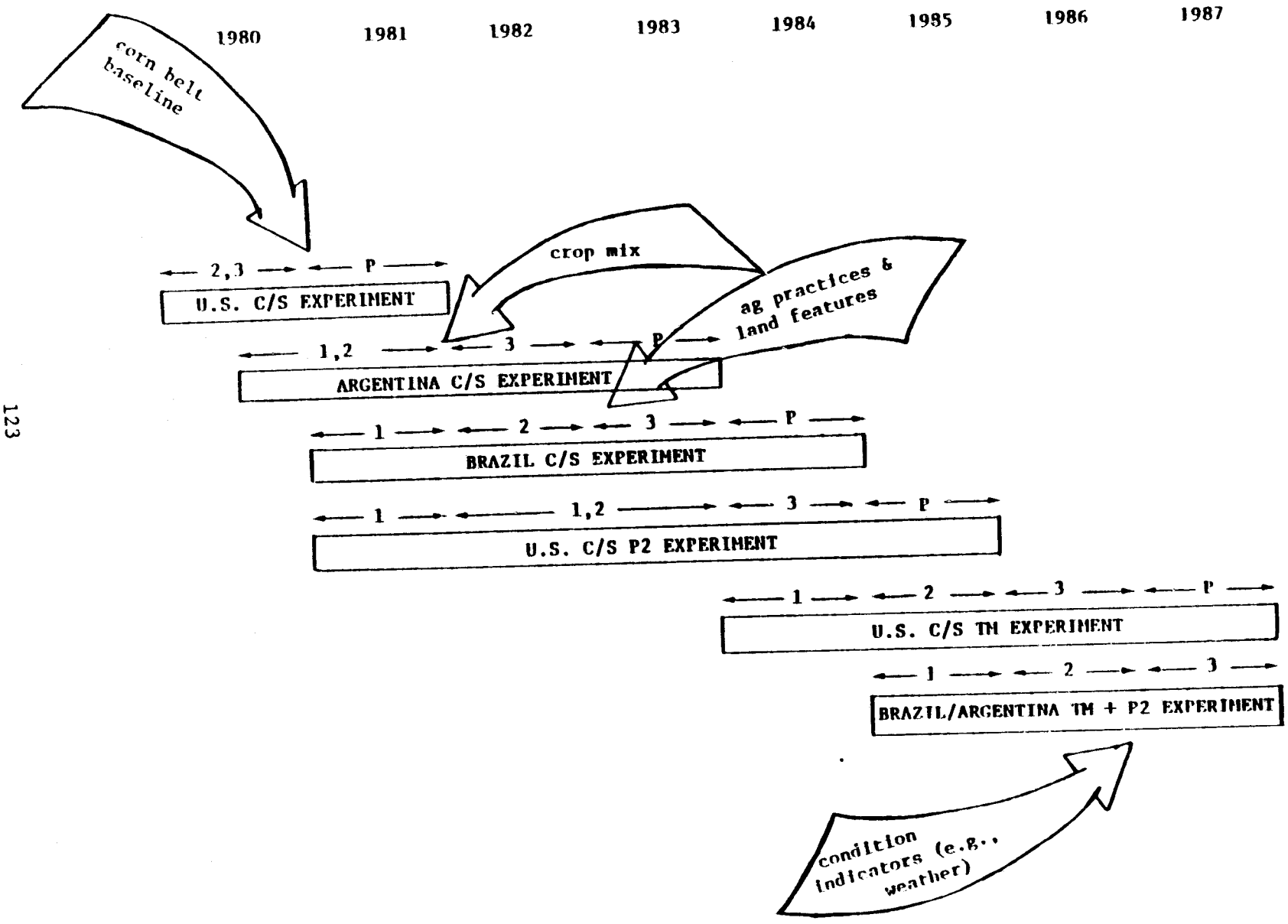
MULTIPURPOSE AGRICULTURE INVENTORY



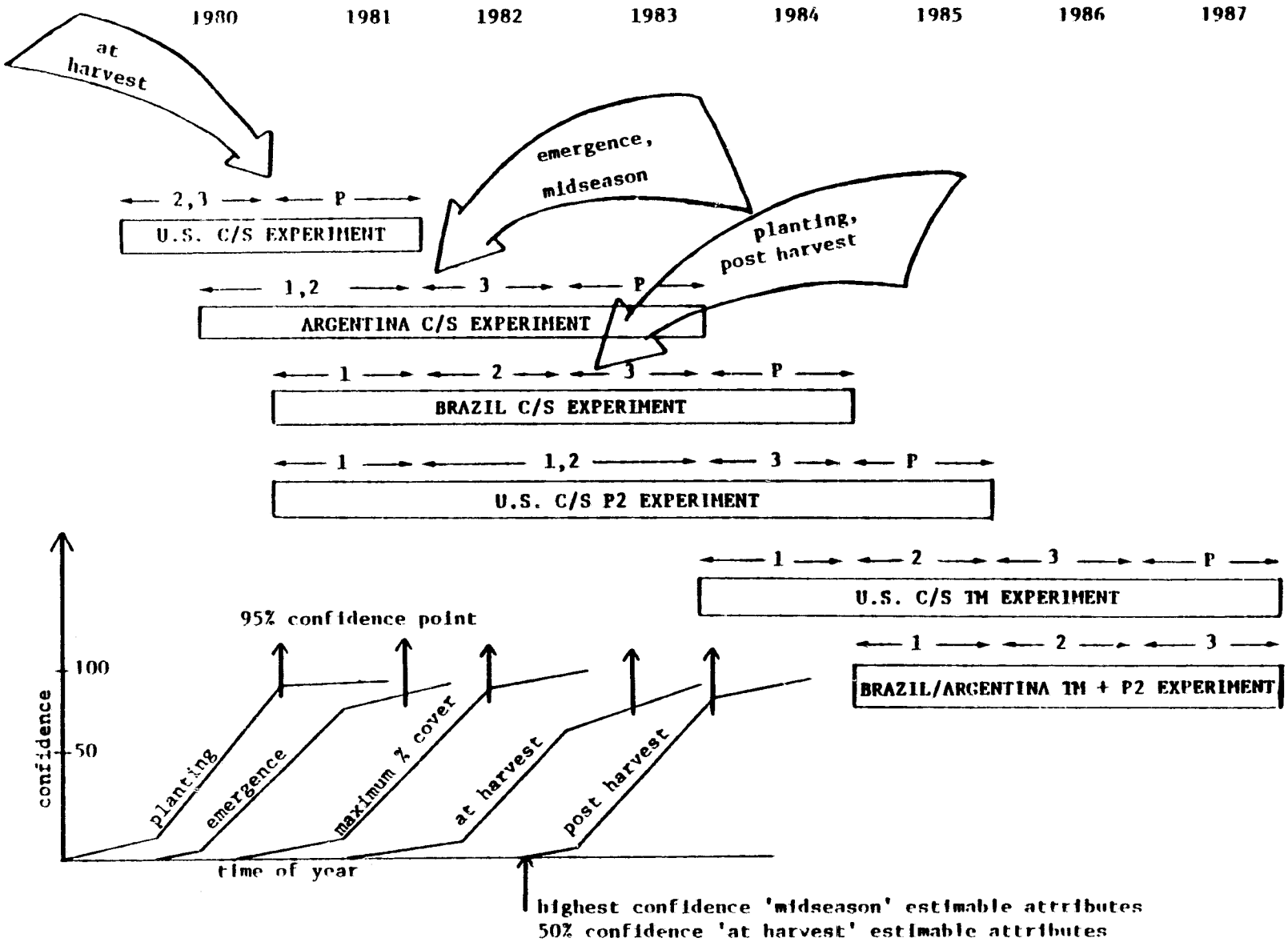
SENSOR TECHNOLOGY



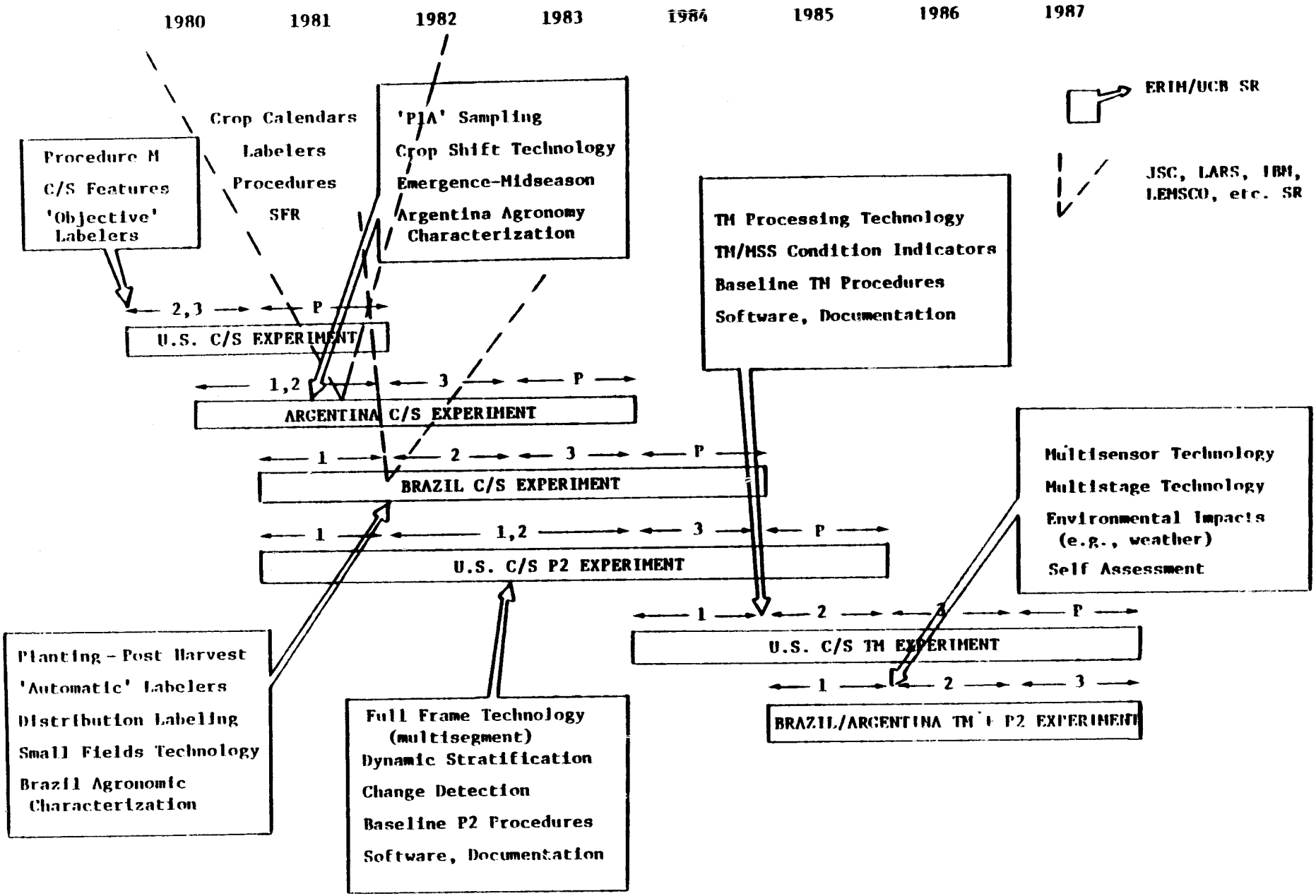
FOREIGN UNDERSTANDING



THROUGH-THE-SEASON ESTIMATION



SUPPORTING RESEARCH FOR CORN AND SOYBEAN FOREIGN COMMODITY PRODUCTION FORECASTING



SR C/S CLASSIFICATION TECHNOLOGY DEVELOPMENT

ACTIVITIES AND ACCOMPLISHMENTS

(15 FEB '80 - 7 OCT '80)

GENERAL

- SUPPORTED PCR TO SWITCH ORDER FOR BRAZIL AND ARGENTINA FOREIGN APPLICATIONS

- SUPPORTED DEVELOPMENT OF DRAFT PLAN FOR COOPERATIVE RESEARCH PROGRAM WITH BRAZIL

- SUPPORTED REPLANNING BY SR IN ANTICIPATION OF
  - TWO YEAR DELAY IN TM DATA
  - ONE YEAR GAP IN MSS DATA (P2 EXP. DELAY)

SR C/S CLASSIFICATION TECHNOLOGY DEVELOPMENT

ACTIVITIES AND ACCOMPLISHMENTS (CONTINUED)

(15 FEB '80 - 7 OCT '80)

SEGMENT-BASED TECHNOLOGY

- SUPPORTED DESIGN OF FCPF BASELINE PROCEDURE FOR FY 81 US C/S PILOT
- ESTABLISHED DEFINITIONS FOR "THROUGH-THE-SEASON"
  - PREDICTABLE A PRIORI
  - ACCURACY PLATEAUS
- INITIATED DEVELOPMENT OF LABELING GUIDELINES
  - EMERGENCE
  - MID-SEASON
- DEFINED AND IMPLEMENTED (FOR SR T&E) PROCEDURE FOR SAMPLING/ESTIMATION WITH PRIORS

ACTIVITIES AND ACCOMPLISHMENTS (CONTINUED)

(15 FEB 80 - 7 OCT 80)

FULL FRAME BASED TECHNOLOGY

- INITIATED LIAISON WITH FCPF SAMPLING AND AGGREGATION P-2 RESEARCH TEAM

THEMATIC MAPPER BASED TECHNOLOGY

(TASK NOT YET INITIATED)

SR C/S CLASSIFICATION TECHNOLOGY DEVELOPMENT

NEAR TERM PLANS

GENERAL

- DEVELOP DETAILED IMPLEMENTATION PLAN FOR FY81 - FY82
- SUPPORT DEVELOPMENT OF NASA/INPE (BRAZIL) COOPERATIVE AGREEMENT AND SIMILAR INITIATIVE WITH ARGENTINA

NEAR TERM PLANS (CONTINUED)

SEGMENT BASED TECHNOLOGY

- DEFINE LABELING GUIDELINES FOR EMERGENCE AND MID SEASON (15 Nov 80)
- DELIVER PRELIMINARY LABELING PROCEDURES TO FCPF FOR ARGENTINA EXPLORATORY EXPERIMENT (1 MAY 81)
- COMPLETE SR EVALUATION OF SAMPLING/ESTIMATION WITH PRIORS AND DELIVER TO FCPF FOR ARGENTINA EXPLORATORY EXPERIMENT (15 DEC 80*)

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*REPRESENTS 1 MONTH SLIP WHICH WILL NOT IMPACT FCPF SCHEDULES.

NEAR TERM PLANS (CONTINUED)

FULL FRAME BASED TECHNOLOGY

- INITIATE DEVELOPMENT OF P-2 RESEARCH PLAN (15 DEC 80)
- INITIATE RESEARCH IN DYNAMIC STRATIFICATION (15 FEB 81)

TM BASED TECHNOLOGY

(NO ACTIVITY IN FY 81)

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